

Microcomputer Vendor Directory



Software • Hardware

Microcomputer Vendor Directory

Software/Hardware



Microcomputer Vendor Directory

Software/Hardware

**Produced by the Editorial Staff of
AUERBACH Publishers**

Charles R. Campbell
Managing Editor

John Whalen
Senior Editor

Christopher Albertus
Assistant Editor

Kathleen Brust
Assistant Editor

Oliver Picher
Assistant Editor

Maureen Carroll
Editorial Assistant

Rita Bryant
Editorial Coordinator

K
COL 64
19583
1984

The information contained in the Microcomputer Vendor Directory is obtained from sources considered reliable. It is reviewed, edited, and evaluated by experienced technical personnel. However, the complete accuracy of this information cannot be and is not guaranteed.

ISBN 0-87769-274-2

© 1984 by Auerbach Publishers Inc. All rights reserved. Except for use in review, the reproduction of this work by any electronic, mechanical, or other means now known or hereafter invented (including xerography, photocopying, and recording), or the utilization of any form of this work in any information storage and retrieval system is forbidden without the written permission of the publisher.

Published by AUERBACH Publishers Inc
Pennsauken NJ 08109

Manufactured and Printed in the United States of America

INTRODUCTION

Auerbach Publishers has designed this Microcomputer Vendor Directory to provide you with a current and conveniently organized listing of microcomputer software, hardware, and peripherals vendors.

Once you have selected the software package or system that best satisfies your requirements, you are encouraged to use this Directory to save time and effort when contacting vendors.

The first section alphabetically lists all the microcomputer vendors featured in Auerbach's *MicroWorld* service, with the complete vendor name, street address, city, state, zip code, and telephone number. In addition we have provided the generic type of micro software and hardware currently offered by each vendor.

The second section, which lists microcomputer vendors by the products they offer, is organized according to specific hardware and software categories, such as accounts payable software, or accounts receivable software, or diskettes. All vendors who market products under a given category are listed in alphabetical order.

The last section comprises a handy glossary of terms and feature articles that address the application of micros in a variety of environments. The glossary provides you with the vocabulary you'll need to communicate effectively with the vendors you've located in the Directory. It also explains the abbreviations used in your *MicroWorld* service.

AUERBACH PUBLISHERS INC

Data processing and business professionals turn to Auerbach for reliable and current information to aid cost-effective, sound purchasing and management decisions.

Auerbach's full line of management and technology information services in the fields of data processing, data communications, office automation, manufacturing resource planning, and telecommunications support such decisions for professionals worldwide.

No bound book can provide such timely information nor can any periodical provide such comprehensive information as an Auerbach information service.

All Auerbach information is presented in a well organized, fully indexed format so the data you need is easily accessible. You do not waste time searching through hundreds of irrelevant reports.

Discover for yourself the value of an Auerbach service.

On the back cover of this Directory you will find a complete list of Auerbach services. Throughout North America all Auerbach services are available on a 15-day-trial basis at no cost or obligation.

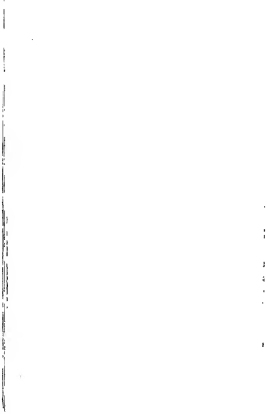
Internationally, information pertaining to these services may be obtained by writing to

**Auerbach Publishers Inc
6360 North Park Drive
Parsippany NJ 08109 USA.**

For immediate service, please call us toll-free at

**800-257-6162
(In New Jersey 609-662-2070)
or Telex 831 464.**

Alphabetic Vendor Directory



ALPHABETIC VENDOR DIRECTORY

AB COMPUTERS

Software: Data Base Management
353 Bethlehem Pike
Colmar PA 18903
(715) 852-7737

ABLE COMPUTER

Hardware: Microcomputers
1733 Reynolds Ave
Irvine CA 92714
(714) 979-7839

ABSTRACT SYSTEMS

Software: Data Communications
85D Lower Prospect Hill
Chester MA 01621
(617) 394-7730

ABW

Software: Data Base Management
PO Box M1047
Aven Arizer MA 01106
(617) 971-5364

ACCELERATED DATA SYSTEMS

Hardware: Microcomputers
1183 Bordeaux
Suite 18
San Jose CA 94086
(408) 744-3364

ACCENT SOFTWARE

Software: Graphics
3750 Wright Pl
Palo Alto CA 94304
(415) 856-6505

ACCESS TECHNOLOGY

Software: Budgeting/Forecasting
4 Pleasant St
South Natick MA 01950
(617) 665-9770

ACCOUNTANTS MICROSYSTEMS

Software: Payroll/Personnel, Integrated Accounting,
Professional Services
1464 140th St NE
Bellevue WA 98007
(206) 643-3993

ACCUPIPE

Software: Graphics
222 W Lancaster Ave
Peapack PA 18051
(715) 298-7345

ACE COMPUTER PRODUCTS

Software: Data Communications
1640 HWY 3rd St
Deerfield Beach FL 33441
(305) 457-1237

ACME SOFTWARE

Software: Sales/Distribution
1737 N First Street
Suite 230
San Jose CA 95130
(408) 268-3333

ACORN COMPUTERS LTD

Hardware: Microcomputers
44 Market Hill
Cambridge
England CB2 3PQ
Telephone: (0223)241000

ACORN SOFTWARE PRODUCTS

Software: Utilities
434 N Caroline Ave SE
Washington DC 20003
(202) 462-4300

ACTION COMPUTER ENTERPRISE

Hardware: Microcomputers
55 W Del Mar Blvd
Pasadena CA 91130
(213) 790-3440

ACTIVE COMPUTER ENTERPRISES

Software: Cost Base Management
1953 East Apache Blvd
Tempe AZ 85281
(602) 968-3350

ADDISON-WESLEY PUBLISHING

Software: Budgeting/Forecasting
Jacob Way
Reading MA 01867
(617) 944-2700

ADVANCED DATA SYSTEMS

Software: Data Communications

7888 Maple Ave
St Louis MO 63143
(314) 761-5368

ADVANCED MANAGEMENT STRATEGIES

Software: Budgeting/Forecasting

Suite 200
1933 Cliff Valley Way
Atlanta GA 30329
(404) 448-8717

ADVANCED MICRO DEVICES

Hardware: Add-on Memory

901 Thompson Pl
San Jose CA 95091
(408) 732-2600

ADVANCED STRUCTURAL TECHNOLOGY

Software: Engineering/Scientific

PO Box 18655
Chaparral MO 63026
(314) 732-8362

ADVENTURE INTERNATIONAL

Software: Language

Box 3493
Longwood FL 32750
(305) 830-8774

AEM COMPUTER SERVICES

Software: Professional Services

3281 E. Charles Oak Rd
Scottsdale AZ 85254
(602) 942-8382

AERONICA

Software: Professional Services

Secaucus
4530 Park Rd Suite 348
Charlotte NC 28206
(704) 325-9881

AF SOFTWARE SERVICES

Software: Professional Services

1156 Greenfield Circle
Geneva IL 60134
(312) 232-0760

AGDATA

Software: Professional Services

891 Hazel St
Orkeley CA 95940
(914) 646-6283

AGRICULTURAL MANAGEMENT SYSTEMS

Software: Professional Services

2770 Vista Ave
Boca ID 83705
(208) 348-0360

AK ROSENHAN, CONSULTING ENGINEER

Software: Professional Services

Onwater Rd
Mississippi State MS 39762
(601) 325-1866

ALCOR SYSTEMS

Software: Language

800 West Garland Avenue Suite 100
Garland TX 75040
(214) 494-1016

ALEXANDER GRANT & CO

Software: Integrated Accounting

235 Capital Mall
Suite 100
Sacramento CA 95814
(916) 441-7222

ALPHA MICRO

Hardware: Microcomputers, Diskettes, Add-on Memory

17881 Sky Park Rd
PO Box 18047
Irvine CA 92713
(714) 957-1404

ALPHA OMEGA COMPUTER SYSTEMS

Hardware: Add-on Memory

33071 Rutledge Circle
PO Box 12
Corvallis OR 97330
(503) 754-1571

ALPHABIT COMMUNICATIONS

Software: Graphics, Word Processing/Text Editing

11047 Michigan Ave
Dearborn MI 48126
(313) 561-2666

ALTOS COMPUTER SYSTEMS

Hardware: Microcomputers

2160 Bering Dr
San Jose CA 95131
(408) 546-6700

AMERICAN BELL**Hardware: Modems**

Headquarters Plaza
One Speedwell Ave. Box 5333
Minnetonka MN 55305
(201) 898-0337

AMERICAN BUSINESS SYSTEMS**Software: Accounts Payable, Accounts Receivable,
General Ledger, Payroll/Personnel,
Sales/Distribution**

3 Littleton Rd.
Westford MA 01886
(617) 892-2600

**AMERICAN COMPUTERS &
ENGINEERS****Software: Graphics****Hardware: Microcomputers**

2021 Barrington Ave. #204
Los Angeles CA 90028
(213) 477-6758

AMERICAN PLANNING**Software: Languages**

4800 Duke at
Suite 403
Alexandria VA 22304
(703) 739-2374

AMPEX**Hardware: Workstations**

Ministry Products Div.
208 H. Frank St.
El Segundo CA 90245
(213) 640-9139

ANACOMP**Software: Manufacturing**

13858 SE 45th Pl.
Bellevue WA 98006
(206) 441-4950

ANADIX**Hardware: Processors**

9825 De Soto Ave.
Chatsworth CA 91311
(213) 964-6060

ANATROL**Software: Engineering/Scientific**

Suite 227
17305 Reed Hartman Highway
Cincinnati OH 45240
(513) 964-5000

ANDENT**Software: Professional Services**

1000 North Ave.
Waukegan IL 60085
(312) 244-0290

ANDERSON JACOBSON**Hardware: Disasters, Peripherals**

321 Charcot Ave.
San Jose CA 95131
(408) 263-8539

ANDROMEDA SYSTEMS**Hardware: Add-on Hardware**

9000 Egan Ave.
Caroga Pl. CA 91304
(213) 709-7603

ANDROMEDA SYSTEMS

9000 Egan Ave.
Caroga Pl. CA 91304
(213) 709-7603

ANOTHER DIRECTION**Software: Professional Services**

19 Rolling Road
East Brunswick NJ 08826
(201) 238-1333

ANTHRO-DIGITAL**Software: Utilities**

133 Bartlett Avenue
Forsfield MA 01204
(617) 440-8276

APPARAT**Hardware: Add-on Hardware**

4401 S. Tamarac Pkwy.
Denver CO 80237
(303) 741-1776

APPEL & KREISS SOFTWARE**Software: Professional Services**

78 Alvon Street
Woodbridge NJ 07095
(201) 434-7137

APPLE COMPUTER**Software: Graphics, Operating Systems, Languages****Hardware: Microcomputers, Workstations, Disasters,
Peripherals**

10540 Sandley Dr.
Cupertino CA 95014
(408) 996-1370

APPLIED DIGITAL DATA SYSTEMS

Hardware: Microcomputers

180 Marcus Blvd
Hauppauge NY 11787
(516) 221-9400

APPLIED MICROCOMPUTER SYSTEMS

Software: Word Processing/Text Editing

Box 150
Silver Lake NH 03071
(603) 367-6004

APPLIED SOFTWARE TECHNOLOGY

Software: Data Base Management

14125 Capri Dr
Suite 4
Los Gatos CA 95030
(408) 359-2662

APPLIED SYSTEMS

Software: Professional Services

Hardware: Microcomputers

26401 Harper
Suite 1
St. Clair Shores MI 48081
(313) 779-6100

APPLIED TECHNOLOGY VENTURES

Software: Word Processing/Text Editing

610 National City
14th Bldg
Cleveland OH 44114
(216) 597-0525

ARBUS TOTALSOFT

Software: Professional Services

4200 Guide Meridian
Suite 714
Bellevue WA 98006
(206) 731-6404

AEGOS SOFTWARE

Software: Job Costing, Integrated Accounting

790 W Shaw Ave
Suite 360
Fresno CA 93704
(209) 221-7271

ARM

Software: Professional Services

8245 Northway St Street Suite 111
Miami FL 33156
(305) 594-2525

AEROW MICRO SOFTWARE

Software: Data Communications

11 Kingsford
Kenzie CT 0-26 175
Canada
(612) 582-6609

ARTSOI

Software: Word Processing/Text Editing

2547 Salsman Ave
North Hollywood CA 91601
(213) 965-7600

ASHTON-TATE

Software: Budgeting/Forecasting, Cash Flow Management

10130 W Jefferson Blvd
Culver City CA 90230
(213) 204-5270

ASK MICRO

Software: Accounts Payable, Accounts Receivable, General Ledger, Payroll/Personnel, Integrated Accounting, Sales/Distribution

100 Blue Avenue Rd
Folsom CA 95630
(916) 966-6000

ASPEN SOFTWARE

Software: Program Development/Debugging

PO Box 891
Tulsa OK 74109
(606) 281-1171

AST RESEARCH

Hardware: Add-on Memory

2072 Morse Ave
Irvine CA 92714
(714) 546-1100

ASTROCOM

Hardware: Modems

130 W Flaco
St. Paul MN 55107
(612) 227-6601

ATARI

Software: Word Processing/Text Editing

Hardware: Microcomputers, Modems

1365 Bonnegas Ave
PO Box 427
Sunnyvale CA 94086
(408) 530-6547

ATASI

Hardware: Microcomputers

226 Chantrel Ave
San Jose CA 95131
(408) 540-0770

ATON INTERNATIONAL

Software: Word Processing/Text Editing, Operating Systems, Data Communications

280 Broadway Ave
San Jose, CA 95128
(408) 286-8078

AUTODESK

Software: Graphics

18 St. Jude Rd
Mill Valley, CA 94041
(415) 381-1819

AUTOGRAPHIX

Software: Graphics

100 Fifth Ave
Waltham, MA 02154
(617) 890-8538

**AUTOMATED INSURANCE
RATING SERVICES**

Software: Budgeting/Forecasting

361 Sandy Beach Suite 101
Carol Stream, IL 60817
(312) 482-0910

**AUTOMATED RESOURCE
MANAGEMENT**

Hardware: Workstations

3813 W. MacArthur Blvd
Santa Clara, CA 95051
(714) 850-7134

AZUREDATA

Hardware: Printers

4102 148th Ave NW
Redmond, WA 98072
(206) 881-5700

B-SQUARED

Software: Sales/Distribution

PO Box 26816
Tempe, AZ 85282
(602) 834-8888

BARRINGTON INTERNATIONAL

Hardware: Microcomputers

738 Airport Blvd
Suite 4
Ann Arbor, MI 48104
(313) 768-7811

BASF SYSTEMS

Hardware: Workstations

Croftby Dr
Bedford, MA 01730
(617) 271-4958

BASIS

Hardware: Microcomputers

5405 Scotts Valley Dr
Scotts Valley, CA 95066
(408) 438-5804

BEAMAN PORTER

Software: Word Processing/Text Editing

Pleasant Ridge Rd
Harrison, NY 10528
(914) 967-3304

BERNARD GIFFLER ASSOCIATES

Software: Manufacturing

34 Linda Lane
Warrington, PA 18906
(215) 343-3345

BGL TECHNOLOGY

Hardware: Disks/ettes

19452 Cabrillo Rd
Suite 207
Van Nuys, CA 91408
(818) 787-0525

BILLINGS COMPUTER

Hardware: Microcomputers

18628 E. 27th Terrace S
Independence, MO 64057
(816) 373-0300

BINKLEY SOFTWARE

Software: Engineering/Scientific

7346 Sharon Dr
San Jose, CA 95121
(408) 257-9532

BIZCOMP

Hardware: Modems

PO Box 7498
Merito Park, CA 94025
(415) 745-1844

BLACKHAWK COMPUTERS

Hardware: Microcomputers

712 19th St
Barnesboro, IA 52003
(319) 325-8887

BMC COMPUTER

Hardware: Microcomputers

860 E. Walnut St
Canon, CA 92016
(714) 332-2800

BPI SYSTEMS

Software: Integrated Accounting

3403 Goodridge
Austin, TX 78703
(512) 454-2801

BREEZE/QSD

Software: Graphics, Utilities

11000 Stations Expressway
Suite 120
Dallas TX 75220
(214) 464-2094

BRISTOL INFORMATION SYSTEMS

Software: Accounts Receivable, Payroll/Personnel, Sales/Distribution, Professional Services

84 North Main Street
Fall River MA 02720
(617) 479-1081

BRODERBUND SOFTWARE

Software: Word Processing/Text Editing

1008 Fourth St.
San Rafael CA 94901
(415) 454-6434

BURROUGHS

Software: Accounts Payable, Accounts Receivable, General Ledger, Payroll/Personnel, Sales/Distribution

Hardware: Microcomputers

Burroughs Pl
Detroit MI 48202
(313) 572-7000

BUSINESS & PROFESSIONAL SOFTWARE

Software: Graphics

140 Binney St
Cambridge MA 02142
(617) 451-3377

BUSINESS PLANNING SYSTEMS

Software: Budgeting/Forecasting

Two N State St.
Clever DE 19801
(302) 674-2300

BUSINESS SOLUTIONS

Software: Budgeting/Forecasting

40 E Main St.
Kings Park NY 11754
(516) 365-1120

BYTEK

Software: Program Development/Debugging

1714 Solano Ave.
Berkeley CA 94707
(415) 827-1157

CAH VIDEO

Software: Graphics

170 W Caracas Ave.
Hendley PA 17030
(717) 503-6460

CADO SYSTEMS

Software: Professional Services

Hardware: Microcomputers

2771 Tolando St.
Romance CA 90060
(213) 300-9460

CALIFORNIA DIGITAL ENGINEERING

Software: Word Processing/Text Editing

PO Box 526
Hollywood CA 90028
(213) 461-0021

CALLAN DATA SYSTEMS

Hardware: Microcomputers

2407 Tanagergate Rd.
Westlake Village CA 91361
(213) 391-6134

CAMBEX

Hardware: Address Memories

360 Second St.
Waltham MA 02154
(617) 890-6000

CAMPBELL SCIENTIFIC

Hardware: Microcomputers, Plots, Modules

PO Box 520
Logan UT 84301
(801) 753-2342

CANON USA

Hardware: Microcomputers

One Canon Plaza
Lake Success NY 11042-9079
(516) 466-6700

CAPRO

Hardware: Microcomputers

12080 Pala Dr.
Carden Grove CA 95041
(714) 891-7100

CASIO

Hardware: Microcomputers

15 Gardner Rd.
Fairfield NJ 07004
(201) 375-7400

CAXTON SOFTWARE PUBLISHING

Software: Data Base Management
19-14 Bedford Street
Caversham Garden
London WC2R 9HE
England

CENTRAL DATA

Hardware: Microcomputers, Add-on Memory
1803 Newton Dr
Champaign IL 61820
(312) 399-8010

CENTRONICS DATA COMPUTER

Hardware: Peripherals
11 Wall St
Hoboken NJ 07030
(602) 682-0111

CENTURION COMPUTER

Hardware: Microcomputers
1302 E. Alameda Rd
Richardson TX 75081
(214) 934-5729

CERAMTEK

Hardware: Modems
1308 Bonaparte Ave
Sunnyvale CA 94086
(408) 734-8180

CHANG LABORATORIES

Software: Budgeting/Forecasting
10038 N. Isidore Rd
Cupertino CA 95014
(408) 725-8888

CHARLES RIVER DATA SYSTEMS

Hardware: Microcomputers
4 Tech Circle
Fitch MA 01760
(617) 632-1800

CHRISLIN INDUSTRIES

Hardware: Microcomputers, Disks, Add-on Memory
31032 Via Collins
Box 101
Westlake Village CA 91362
(714) 991-2294

CHROMATICS

Hardware: Microcomputers, Add-on Memory
2550 Mountain Industrial Blvd
Tucker GA 30084
(404) 493-7000

CIFER SYSTEMS LTD

Hardware: Microcomputers
June Way, Broomfield
Hemel Hempstead, Herts
England SP412 6TP
Telephone: (0425) 708241

CLIENT ACCOUNTING SYSTEMS

Software: Professional Services
2321 Hill 40th Ave. #213
Ft Lauderdale FL 33313
(305) 733-3127

CMA MICRO COMPUTER

Software: Professional Services
55722 Santa Fe Trail
Yucca Valley CA 92384
(619) 363-0718

CMV SOFTWARE SPECIALISTS

Software: Professional Services
212 W. Russell
Sloan Falls ID 83704
(903) 338-6643

COASTAL COMPUTER

PO Box 808
822 Lafayette Rd
Hampton NH 03842
(603) 926-4326

CODEX

Hardware: Modems
20 Cabot Blvd
Hartford MA 02048
(603) 364-2000

COHERENT COMMUNICATIONS

Hardware: Modems
40 Commerce Dr
Hauppauge NY 11788
(516) 895-6274

COLONIAL DATA SERVICES

Hardware: Microcomputers
105 Sanford St
Hamden CT 06414
(203) 399-2534

COLUMBIA DATA PRODUCTS

Hardware: Microcomputers
8980 Route 108
Columbia MD 21045
(301) 990-3400

COMARK

Hardware: Microcomputers, Workstations, Diskettes

207 Caspary St.
Wattham MA 02154
(617) 894-7000**COMDATA**

Hardware: Modems

7600 N. Hagler Ave.
Morton Grove IL 60053
(312) 470-9500**COMMODORE BUSINESS MACHINES**

Hardware: Microcomputers, Diskettes, Address Memosets, Plotters, Modems

487 Cleven Park Dr.
Wayne PA 19087
(215) 487-8700**THE COMMUNE TREE GROUP**

Software: Data Communications

470 Cedar
Suite 207-2002
San Francisco CA 94114
(415) 424-0903**COMPAC SYSTEMS**

Software: Word Processing/Text Editing

59 E. Cunningham Dr.
Palatine IL 60067
(312) 399-8066**COMPAL COMPUTER SYSTEMS**

Hardware: Microcomputers

8320 Wilshire Blvd.
Beverly Hills CA 90211
(310) 652-2062**COMPAQ COMPUTER**

Hardware: Microcomputers

12200 Perry Rd.
Houston TX 77060
(713) 890-7700**COMPLETE COMPUTER SYSTEMS**

Software: Word Processing/Text Editing

157 Calverton Rd.
Prudential Business Campus
Horseshoe PA 19044
(215) 447-4300**COMPUGRAPHIC**

Software: Accounts Receivable

280 Ballardville St.
Wilmington MA 01897
(617) 658-5600**COMPUMAX**

Software: Sales/Production, Manufacturing, Data Base Management

PO Box 7239
Menlo Park CA 94023
(415) 654-6700**COMUPRO**

Hardware: Microcomputers

8047 725 PO Box 2706
Oakland Airport CA 94614
(415) 562-0626**COMPUSOL**

Software: Professional Services

H. Carter Sq. #128
3434 Buford Hwy
Doraville GA 30040
(404) 451-1033**COMPUTEK**

Software: Word Processing/Text Editing

62 Second Ave.
Burlington MA 01803
(617) 273-6700**COMPUTER ANCILLARIES LTD**

Hardware: Microcomputers

64 High St.
Bgham, Surrey
England TW20 9DY
Telephone: (270) 34-455**COMPUTER: APPLICATIONS**

Software: Data Communications

13500 JW 106 Street Circle
Miami FL 33196
(305) 365-4277**COMPUTER AUTOMATION**

Hardware: Microcomputers

2181 Dupont Dr.
Irvine CA 92713
(714) 833-8500**COMPUTER CONSULTING SERVICES**

Software: Professional Services

1833 Drew St.
Clearwater FL 33515
(813) 489-2640**COMPUTER CONTROL SYSTEMS**

Software: Utilities

298 21st Terrace SE
Largo FL 33040
(813) 556-3986

COMPUTER DATA

Software: Program Development/Debugging
130 Mainway St
Warwick RI 02886
(401) 738-5265

COMPUTER DEVELOPMENT

Software: Word Processing/Text Editing
4700 SW 188th St
Beverton OR 97005
(503) 648-1299

COMPUTER DEVICES

Hardware: Microcomputers, Printers
Two Penn Plaza
Suite 1400
New York NY 10121
(212) 495-3225

COMPUTER EXTENSION SYSTEMS

Hardware: Add-on Modules
17511 El Camino Road
Suite 121
Houston TX 77058
(713) 488-8226

COMPUTER HEADWARE

Software: Data Base Management
PO Box 14094
San Francisco CA 94114
(415) 643-8218

COMPUTER INNOVATIONS

Software: Languages
10 Inchausti St
Suite 2-102
Bedford NJ 07001
(201) 338-0965

COMPUTER MARKETING SERVICES

Software: Budgeting/Forecasting, Word Processing/Text Editing
300 W Madison Pike
Cherry Hill NJ 08002
(609) 799-1480

COMPUTER METHODS

Software: Manufacturing
10525 W Oklahoma Ave
Milwaukee WI 53227
(414) 327-4671

COMPUTER METHODS OF PENNSYLVANIA

Software: Program Development/Debugging
525 Hansen Road
King of Prussia PA 19406
(215) 268-2580

COMPUTER OPTIONS

Software: Job-Costing
142 Crescent St
Brockton MA 02402
(617) 583-5481

COMPUTER PRODUCTS

Software: Payroll/Personnel, Program Development/Debugging
3225 County Park
New Orleans LA 70002
(504) 452-5120

COMPUTER STATIONS

Software: Graphics, Data Communications
118-11 Page Service Drive
St Louis MO 63141
(314) 432-7079

COMPUTER SYSTEM ASSOCIATES

Hardware: Workstations
7962 Trade St
San Diego CA 92121
(714) 544-2991

COMPUTER TASK GROUP

Software: Professional Services
820 Gallinger Avenue
Buffalo NY 14208
(716) 852-8020

COMPUTER TRANSCEIVER SYSTEMS

Hardware: Printers
E M Villand Ave
PO Box 15
Panama NJ 07652
(201) 261-6820

THE COMPUTERIST

Hardware: Microcomputers
PO Box 3
34 Chalmers Rd
S Chalmers MA 01834
(617) 334-3449

COMPUTERS INTERNATIONAL

Hardware: Printers
3540 Wilshire Blvd
Los Angeles CA 90010
(213) 384-1171

COMPUTHINK

Hardware: Microcomputers
965 West Alameda Ave
Sunnyvale CA 94086
(408) 245-8225

COMPUTING

Software: Utilities

2019 Greenwold Street
San Francisco CA 94133
(415) 567-1634

COMPUTONE SYSTEMS

Software: Professional Services

One Dunwoody Park
Atlanta GA 30338
(404) 393-3000

COMREX INTERNATIONAL

Hardware: Filters, Display Interfaces

1001 Maypark Dr
Suite 100
Torrance CA 90505
(213) 379-0300

COMSHARE

Software: Budgeting/Forecasting

3021 S State St
Ann Arbor MI 48104
(313) 994-4800

COMSHARE TARGET SOFTWARE

Software: Budgeting/Forecasting

7005 Cliff Valley Way
Suite 200
Atlanta GA 30329
(404) 634-9535

CONDOR COMPUTER

Software: Data Base Management

3051 S State St
Ann Arbor MI 48104
(313) 760-0568

CONSTRUCTION DATA CONTROL

Software: General Ledger, Payroll/Personnel, Job Costing, Integrated Accounting, Word Processing/Text Editing, Data Base Management

3050 Mirena Rd
Tucker GA 30084
(404) 934-4722

CONTEXT MANAGEMENT SYSTEMS

Software: Budgeting/Forecasting, Data Communications

12884 Flamingo Ave
Suite 100
Torrance CA 90505
(313) 379-6277

CONTINENTAL SOFTWARE

Software: Accounts Receivable, General Ledger

11323 South Hindry Ave
Los Angeles CA 90045
(213) 410-8001

CONTROL DATA

Hardware: Microcomputers

8120 34th Ave S
Minneapolis MN 55440
(612) 653-8100

CONTROL LOGIC

Hardware: Microcomputers

9 Tech Circle
Marblehead MA 01948
(617) 455-1170

CORNUCOPIA SOFTWARE

Software: Word Processing/Text Editing

P.O. Box 5008
Beverly CA 94705
(415) 524-8086

CORVUS SYSTEMS

Hardware: Microcomputers, Minicomps

2029 CTecula Ave
San Jose CA 95131
(408) 940-7700

COSMOPOLITAN ELECTRONICS

Software: Operating Systems

P.O. Box 234
Plymouth MI 48179
(313) 660-6660

COVINGTON COMPUTER SALES

Software: Graphics

280 Pleasant Park Rd
Ottawa ON K2H 5M7
Canada
(613) 337-0844

CP/M USERS GROUP

Software: Data Communications

1821 Third Avenue
New York NY 10038
(212) 750-1286

CREATIVE SOLUTIONS

Software: Program Development/Debugging

4801 Randolph Rd
Rockville MD 20852
(301) 954-0262

CROMEMCO

Software: Graphics, Word Processing/Text Editing,
Hardware: Microcomputers, Add-on Hardware

280 Bernardo Ave.
Menlo Park, CA 94025
(415) 964-7400

CYBERIA

Software: Professional Services, Data Communications

2200 Lincoln Way
Ames, IA 50010
(319) 293-7614

CYBERSYSTEMS

Hardware: Microcomputers

8300 Whitesburg Dr.
Huntsville, AL 35892
(205) 381-4400

CYMA

Software: Accounts Payable, Accounts Receivable,
General Ledger, Payroll/Personnel, Integrated
Accounting, Professional Services

1630 E University Dr.
Mesa, AZ 85200
(602) 825-8880

CYNTHIA PERIPHERAL

Hardware: Workstations

3608 W. Bayshore Rd.
Palo Alto, CA 94302
(415) 856-5181

CYPHER COMMUNICATIONS TECHNOLOGY

Software: Data Communications

Suite 1000
1712 I St. NW
Washington, DC 20006
(202) 897-0834

DAKINS

Software: Budgeting/Forecasting, Professional Services,
Program Development/Debugging

7475 Dublin St.
P.O. Box 21787
Denver, CO 80221
(303) 438-4090

DATA ACCESS

Software: Program Development/Debugging

4021 Prince of Wales Blvd.
Coral Gables, FL 33146
(305) 448-0666

DATA BASE RESEARCH

Software: Accounts Payable, Accounts Receivable,
General Ledger, Payroll/Personnel,
Sales/Distribution

46 S. Van Gorder
Suite 150
Lakewood, CO 80528
(303) 987-1588

DATA GENERAL

Software: Accounts Receivable, Sales/Distribution
Hardware: Microcomputers

4400 Computer Dr.
Westboro, MA 01581
(617) 364-6911

DATA SYSTEMS & SOFTWARE GROUP

3 Rensselaer Office Plaza
Suite 100
Birmingham, AL 35244
(205) 988-5567

DATA TERMINAL SYSTEMS

Hardware: Microcomputers

124 Action St.
Maynard, MA 02154
(617) 897-3221

DATA TERMINALS & COMMUNICATIONS

Hardware: Prices

388 Division St.
Campbell, CA 95008
(408) 378-1712

DATAGRAPH

Software: Graphics

728 Highway 4 Suite 2
P.O. Box 10
Arnold, CA 95223
(209) 755-5104

DATAMAC COMPUTER SYSTEMS

Hardware: Microcomputers, Add-on Hardware

480 Alvarado Ave.
San Bruno, CA 94066
(408) 725-6523

DATAMARK BUSINESS SYSTEMS

Software: Data Communications

279 S. McKnight Rd.
St. Paul, MN 55119
(612) 738-9171

DATAMED RESEARCH

Software: Word Processing/Text Editing, Utilities

1453 Rossmore Rd.
Los Angeles, CA 90034
(213) 472-0825

DATAMEDIA

Hardware: Microcomputers

7401 Central Highway
Parsippany, NJ 08059
(609) 863-3400

DATAMOST

Software: Word Processing/Text Editing

9740 Canyonville St.
Chenoweth, CA 91311
(714) 706-1202

DATAPPOINT

Hardware: Microcomputers, Printers, Modems

9725 Datapoint Dr.
San Antonio, TX 78204
(512) 499-7532

DATAPRODUCTS

Hardware: Printers

8300 Carnegie Ave.
PO Box 746, MG 2002
Woodland Hills, CA 91366
(213) 887-8800

DATASOFT

Software: Graphics

19579 Business Dr.
Northridge, CA 91340
(213) 706-5961

DATASOUTH

Hardware: Printers

PO Box 240947
4256 Stuart Andrew Blvd.
Charlotte, NC 28224
(704) 523-8300

DATATEK

Software: Word Processing/Text Editing

3821 Enterprise Rd.
Clearwater, FL 33515
(800) 337-6014

DATATRONIX

Hardware: Modems

2500 Rouse Ave.
Reston, VA 22091
(703) 426-5208

DATAVUE

Hardware: Microcomputers

1971 22nd Ave S.
Seattle, WA 98144
(206) 322-9330

DATEC

Hardware: Modems

200 Eastwind Dr.
Suite 118
Chapel Hill, NC 27514
(919) 929-2132

DATEICON

Hardware: Microcomputers

150 "B" Ave.
Lake Oswego, OR 97034
(503) 638-7471

DAVONG SYSTEMS

Hardware: APL-on-Mainframes

1541 Terra Bella Ave.
Mountain View, CA 94040
(415) 963-7130

DECISION RESOURCES

Software: Graphics

PO Box 308
Westport, CT 06881
(203) 337-1974

DEDICATED SYSTEMS

Software: Program Development/Debugging

3440 East Commercial Blvd.
Suite 4
Fort Lauderdale, FL 33308
(305) 491-1530

DELPHIC SOFTWARE SYSTEMS

Software: Program Development/Debugging

325 South Santa Avenue # 25
Solano Beach, CA 92075
(714) 733-6900

DELTA DATA SYSTEMS

Hardware: Microcomputers

2595 Metropolitan Dr.
Erie, PA 16507
(717) 322-5400

THE DENVER SOFTWARE COMPANY

Software: Integrated Accounting, Professional Services

1400 E Jewell Ave.
Suite 15
Aurora, CO 80012
(303) 710-9960

DESIGN SOFTWARE

Software: Program Development/Debugging

4027 E 43rd St.
Tulsa, OK 74134
(918) 481-5855

DESIGNER SOFTWARE

Software: Word Processing/Text Editing

1400 Montrose Blvd
Houston TX 77006
(713) 520-6221

DESIGNERS & BUILDERS OF INFORMATION SYSTEMS (DBIS)

Software: Accounts Payable, Accounts Receivable,
Payroll/Personnel, Sales/Distribution,
Professional Services, Word Processing/Text
Editing, Data Base Management

One Mayfair Rd
Eastchester NY 10807
(516) 779-6793

DESKTOP COMPUTER SOFTWARE

Software: Budgeting/Forecasting

300 Pioneer St
2nd Floor
Santa Cruz CA 95060
(408) 458-9055

DIGICOMP RESEARCH

Hardware: Microcomputers, Address-Memories

Temple Hill
Ithaca NY 14850
(607) 271-1980

DIGILOG BUSINESS SYSTEMS

Hardware: Microcomputers

Welsh Rd & Park Dr
PO Box 318
Montgomeryville PA 18936
(215) 626-6910

DIGITAL CONSTRUCTS

Software: Utilities

130 Main Street
Hartford CT 06101
(203) 279-2632

DIGITAL DESIGN & DEVELOPMENT

Hardware: Microcomputers

PO Box 225
Square 10 Industrial Park
Walpole MA 02081
(617) 668-1000

DIGITAL EQUIPMENT

Software: Budgeting/Forecasting

Hardware: Microcomputers

146 Main Street
Amherst MA 01704
(617) 807-5111

DIGITAL LABORATORIES

Hardware: Microcomputers

400 Pleasant St
Westborough MA 01581
(603) 934-1460

DIGITAL MARKETING

Software: Professional Services, Word Processing/Text
Editing, Data Communications, Utilities,
Program Development/Debugging

2070 Cherry Lane
Walnut Creek CA 94596
(415) 930-2800

DIGITAL MICROSYSTEMS

Software: Manufacturing

Hardware: Microcomputers

1000 Emburydale
Oakland CA 94606
(415) 532-3806

DIGITAL RESEARCH

Software: Graphics, Operating Systems, Utilities,
Languages

PO Box 379
Pacific Grove CA 93950
(408) 649-2896

DISPLAY DATA

Hardware: Microcomputers

Executive Plaza IV
Brent Valley MD 21031
(301) 667-5211

DISTRIBUTED COMPUTER SYSTEMS

Hardware: Microcomputers

221 Crescent St
Waltham MA 02154
(617) 866-6611

DMA SYSTEMS

Hardware: Workstations

401 Pine Ave
Colma CA 94017
(415) 460-3601

DONALD R. FREY & COMPANY

Software: Budgeting/Forecasting

880 Alexandria Pkwy
St Thomas VT 05670
(800) 441-6566

DOTRONIX

Hardware: Display Monitors

160 1st St SE
New Brighton MN 55112
(612) 435-1742

DOW JONES

Software: Data Communications
PO Box 300
Princeton NJ 08540
(609) 257-5574

DP-TEK

Hardware: Printers
PO Box 3401
Milwaukee WI 53201
(716) 481-0876

DUAL SYSTEMS

Hardware: Microcomputers, Addition Memory
2530 San Pablo Ave
Berkeley CA 94702
(415) 549-5834

DURANGO SYSTEMS

Hardware: Microcomputers
3033 N. First St
San Jose CA 95134
(408) 546-5000

DYNABYTE

Hardware: Microcomputers
121 Cantonwood Dr
Milpitas CA 95035
(408) 265-1221

DYNALOGIC INFO-TECH

Hardware: Microcomputers
8 Colonnade Rd
Ottawa, Ontario K2E 7M6
Canada
(613) 236-7711

**DYNAMIC MICROPROCESSOR
ASSOCIATES**

Software: Integrated Accounting, Data Communications,
Utilities
545 Fifth Avenue
New York NY 10017
(212) 467-7775

DYNATEM

Hardware: Microcomputers
23600 O. Lambert St
Suite 1007
El Toro CA 92630
(714) 825-3233

E&I INSTRUMENTS

Hardware: Microcomputers
61 First St
Derby CT 06418
(203) 739-8774

EMU ENGEL CONSULTING

Hardware: Microcomputers
1715 S. Carmelina Ave
Los Angeles CA 90025
(213) 455-4221

EAGLE COMPUTER

Hardware: Microcomputers, Minicomps
582 University Ave
Los Altos CA 94020
(408) 355-3000

EAGLE SOFTWARE PUBLISHING

Software: Professional Services
593 Old Eagle School Road
Wayne PA 19087
(215) 964-8840

EATON PRINTER PRODUCTS

Hardware: Printers
Printer Products
Technical Research Park
Riverton WY 82501
(307) 834-4321

ECOM ASSOCIATES

Software: Engineering/Scientific
8634 W. Brown Deer Road
Milwaukee WI 53224
(414) 354-0243

ECOSOFT

Software: Engineering/Scientific
PO Box 68602
Indianapolis IN 46268
(317) 253-6476

ECS MICROSYSTEMS

Hardware: Microcomputers
215 Devon Dr
San Jose CA 95112
(408) 286-4200

EF HASKELL & ASSOCIATES

Software: Integrated Accounting, Professional Services
1528 E. Main
Suite A101
Phoenix AZ 85014
(602) 277-2534

EINSTEIN

Software: Word Processing/Text Editing, Languages
11348 W. Olympic Blvd
Los Angeles CA 90024
(213) 477-4529

ELLIS COMPUTING

Software: Languages

2917 Noriega St
San Francisco CA 94122
(415) 753-0586

INTEK SCIENTIFIC

Software: Engineering/Scientific

4480 Lake Forest Drive
Suite 208
Cincinnati OH 45242
(513) 562-7500

ENTERPRISE COMPUTER SYSTEM

Software: Professional Services

815 S Main Suite C-16
PO Box 70886
Jacksonville FL 32207
(904) 399-8899

EPIC COMPUTER PRODUCTS

Software: Graphics

Hardware: Microcomputers, Minicomps

10725 81st
Suite B
Mountain View CA 92038
(714) 963-7888

EPS

Software: Budgeting/Forecasting

1788 Technology Dr
San Jose CA 95110
(408) 292-6012

EPSON AMERICA

Hardware: Microcomputers, Minis

3405 Kashiwa St
Torrance CA 90505
(213) 329-7540

ESCAPE COMPUTER SOFTWARE

Software: Graphics

PO Box 1771
Roswell GA 30075
(404) 577-5345

ESP COMPUTER RESOURCES

Software: Data Base Management

9 Ash Street
Methen NH 03048
(603) 465-7364

EUROPEAN AMERICAN BANK

10 Hancock Square
New York NY 10015
(212) 412-4700

EVENTIDE

Hardware: Add-on-Memories

365 W 34th St
New York NY 10019
(212) 981-5290

EVOTEK

Hardware: Minicomps

1225 Page Ave
Fremont CA 94538
(415) 490-2100

EXCALIBUR TECHNOLOGIES

Software: Languages

800 Elm Grande Blvd
Mercede 21
Albuquerque NM 87106
(505) 242-8833

EXECUCOM SYSTEMS

Software: Budgeting/Forecasting

3400 Fair Street Blvd
Austin TX 78721
(212) 348-4900

EXIDY

Hardware: Microcomputers

390 Java Dr
Sunnyvale CA 94088
(408) 734-5440

EZ SOFTWARE

Software: Utilities

PO Box 581
Pleasant CA 94566
(415) 368-0236

FARMLAND COMPUTER SYSTEMS

Software: Professional Services

1035 Sunnyvale-Santaigo Rd
Sunnyvale CA 94087
(408) 746-0626

FIFTH SYSTEMS & SOFTWARE

Software: Accounts Payable, Accounts Receivable,
General Ledger, Payroll/Personnel, Job Costing,
Sales/Distribution, Professional Services,
Manufacturing

204 Main St
Elkins Park PA 19110
(215) 782-8380

PEROX MICROSYSTEMS

Software: Budgeting/Forecasting, Graphics, Data
Communications

1701 N H Jolyer Dr
Suite 601
Arlington VA 22209
(703) 541-0800

FERRANTI COMPUTER SYSTEMS LTD

Hardware: Microcomputers

Sincomway, Wythenshawe
Manchester
England M22 5LA
Telephone: 061-699-1000

FIRST SOFTWARE

Software: Data Communications

5822 E. Peavine
Scottsdale AZ 85254
(602) 953-1308

FORETHOUGHT PRODUCTS

Hardware: Microcomputers, Add-on Memories

87070 Dulkester Rd
Tugene, CA 94602
(913) 489-8575

FORTH

Software: Operating Systems

2308 Pacific Coast Hwy
Hermosa Beach CA 90254
(213) 373-6693

FORTUNE SYSTEMS

Hardware: Microcomputers

1301 Industrial Rd
San Carlos CA 94070
(415) 591-8944

FOX & GELLER

Software: Graphics, Program Development/Debugging

PO Box 1023
Towhee NJ 07066
(201) 837-0542

FRANKLIN COMPUTER

Hardware: Microcomputers, Databases

7000 Colonial Highway
Perris, CA 92370
(607) 488-1700

FRIDAY BUSINESS SYSTEMS

20033 Seagull Way
Saratoga CA 95070
(408) 252-9150

FRIENDS SOFTWARE

Software: Data Base Management

PO Box 107
Berkeley CA 94701
(415) 540-7382

FRONTIER SOFTWARE

Software: Utilities

756 Bowling Green
Cortland NY 13840
(607) 756-8342

FUJITSU

Hardware: Microcomputers, Peripherals

3000 Scott Blvd
Santa Clara CA 95051
(408) 962-0770

FUTURE COMPUTERS LTD

Hardware: Microcomputers

PO Box 306
Purley, Surrey
England
Telephone: 01-488-0348

G. L. INTERSIL SYSTEMS

Hardware: Add-on Memories

1375 Hammonwood Ave
Sunnyvale CA 94086
(408) 743-6442

GANDALF DATA

Hardware: Modems

1071 S Noel Ave
Wheeling IL 60090-5075
(312) 547-6060

GENERAL DATACOMM INDUSTRIES

Hardware: Modems

One Kennedy Ave
Danbury CT 06810
(203) 797-0711

GENERAL DIGITAL INDUSTRIES

Hardware: Microcomputers

505 Wynn Dr
Huntsville AL 35895
(205) 837-8300

GENERAL ELECTRIC

Hardware: Modems

General Electric Drive
Waynesboro VA 22980
(703) 949-1120

GENERAL ROBOTICS

Hardware: Add-on Memories

57 N. Main St
Hartford WI 53027
(414) 473-6000

GENERAL SYSTEMS SCIENCES

Software Sales/Distribution

451 Little Valley Rd
Altamonte Springs FL 32701
(305) 885-4457

GEOGRAPHIX

Software: Graphics

150 N Third St
Philadelphia PA 19106
(215) 525-6890

GIFFORD COMPUTER SYSTEMS

Hardware: Microcomputers

1512 Republic Ave
San Leandro CA 94577
(415) 955-0788

GINIX

Hardware: Microcomputers

1317 W 37 Place
Chicago IL 60609
(312) 527-3310

GMR

Hardware: Microcomputers

1048 E Burgess St
Carson CA 90746
(213) 429-6662

GMS SYSTEMS

Software: Data Base Management

12-1st 37th St
New York NY 10018
(212) 947-3790

GOLDEN STATE BUSINESS SYSTEMS

Software: Engineering/Scientific

1940 F Street
Sacramento CA 95814
(916) 441-2917

GOULD

19000 Pinneridge Ave
Cupertino CA 95014
(408) 956-0508

GRAPHIC COMMUNICATIONS

Software: Graphics

300 Fifth Ave
Waltham MA 02154
(617) 890-8778

GRAPHIC SOFTWARE SYSTEMS

Software: Engineering/Scientific

15717 SW Parkway
PO Box 473
Wilsonville OR 97070
(503) 682-1808

GRAPHICS SOFTWARE

Software: Graphics

1972 Massachusetts Ave
Cambridge MA 02140
(617) 495-2434

GREAT PLAINS SOFTWARE

Software: Integrated Accounting

121 N 19th
 Fargo ND 58103
(701) 750-8460

GRID SYSTEMS

Software: Graphics

Hardware: Microcomputers

2525 Carmel Ave
Mountain View CA 94041
(415) 961-4800

GROUNDSTAR SOFTWARE

Software: Accounts Payable, Accounts Receivable,
General Ledger, Payroll/Personnel, Integrated
Accounting, Sales/Distribution,
Budgeting/Forecasting, Data Base Management

18330 S DeAnza Blvd
Suite 210
Cupertino CA 95014
(408) 448-1400

GRUNDY BUSINESS SYSTEMS LTD

Hardware: Microcomputers

Grundy House
Somerset Rd
Teddington, Middlesex
England TW9 1TD
Telephone: 01-877-1171

GTCO

Software: Graphics

1005 First St
Rockville MD 20850
(301) 279-6050

GTE LENNURT

Hardware: Modems

1105 County Rd
San Carlos CA 94070
(415) 595-3000

H&H SCIENTIFIC

Software: Professional Services

13307 Pendleton St.
Fort Washington MD 20744
(301) 260-2658

HARVARD SOFTWARE

Software: Budgeting/Forecasting

Harvard MA 01461
(617) 488-2400

HAWKEYE GRAPHX

Software: Data Communications

20714 Modine St.
Caroga Park CA 91707
(714) 348-7908

HAYDEN BOOK

Software: Word Processing/Text Editing

50 Dean St.
Bachelle Park NJ 07661
(201) 860-0588

HAYDEN SOFTWARE

Software: Accounts Payable, Accounts Receivable,
General Ledger, Payroll/Personnel,
Sales/Distribution

400 Suffolk
Lowell MA 01851
(617) 807-0200
(800) 343-1218

HAYES MICROCOMPUTER PRODUCTS

Software: Data Communications

Hardware: Modems

5805 Peachtree Corners E
Norcross GA 30092
(404) 449-6791

THE HEADLANDS PRESS

Software: Data Communications

PO Box 862
Tiburon CA 94920
(415) 435-9775

HEATH

Hardware: Printers

PO Box 896
Boston Harbor MA 02003
(617) 962-5200

HECON

Hardware: Printers

PO Box 247
311 Park Road
Tinton Falls NJ 07724
(201) 342-8300

HEURIKON

Hardware: Add-on Modules

3001 Latham Dr.
Madison WI 53703
(608) 271-8700

HEWLETT-PACKARD

Software: Professional Services, Engineering/Science

Hardware: Microcomputers, Minicomputers, Computers,
Printers, Modems

1307 Page Mill Rd.
Palo Alto CA 94304
(415) 866-4681
877 7-HPD1

HFK SOFTWARE

Software: Word Processing/Text Editing

681 Canterbury Rd.
PO Box 190
Danbury NH 05230
(617) 239-0099

HI-G PRINTER PRODUCTS

Hardware: Printers

580 Spring St.
Windsor Locks CT 06096
(203) 423-3340

HIGH TECHNOLOGY SOFTWARE PRODUCTS

Software: Manufacturing

PO Box 40408
1601 HW 22nd St.
Oklahoma City OK 73146
(405) 524-4339

HIGLEY & CO

Software: Payroll/Personnel

PO Box 491
Mendon OH 44860
(216) 346-5099

HOLLIDAY SOFTWARE

Software: Data Base Management, Utilities

4807 Avenida Street
San Diego CA 92117
(714) 262-7766

HONEYWELL INFORMATION SYSTEMS

Hardware: Microcomputers

300 Smith St.
Waltham MA 02154
(617) 255-5600

HORIZON SOFTWARE SYSTEMS

Software: Word Processing/Text Editing

165 Berry St.
San Francisco CA 94107
(415) 342-1099

HOURLASS SYSTEMS

Software: Budgeting/Forecasting

PO Box 312
Green Hills IL 62117
(312) 490-1880

HOWARD SOFTWARE SERVICES

Software: Professional Services

8008 Grand Avenue
Suite 110
La Jolla CA 92037
(619) 454-0121

HUMAN ENGINEERED SOFTWARE

Software: Graphics, Word Processing/Text Editing

71 Park La
Baldwin CA 94005
(415) 488-4710

HUMAN SYSTEMS DYNAMICS

Software: Budgeting/Forecasting, Graphics

1049 Kinross Blvd Suite 107
Hawthorne CA 91324
(714) 991-6516

HUNTER & READY

Software: Operating Systems

445 Sherman Ave
Folsom CA 94008
(415) 338-0560

IBM

Software: Operating Systems, Data Communications
Hardware: Microcomputers

1133 Winchester Ave
White Plains NY 10604
(914) 698-1900

ICL COMPUTERS

Hardware: Microcomputers

North American Operation
4701 E. Airport Freeway
Irving TX 75062
(214) 258-8525

ICOT

Hardware: Modems

800 Inland Ave
Mountain View CA 94041
(415) 964-4525

IDE ASSOCIATES

Hardware: Add-on Monitors

44 Mill Rd
Burlington MA 01803
(617) 273-7340

IE SYSTEMS

Software: Data Communications

98 Main St
Newmarket NH 03857
(603) 469-0881

IIG

Software: Word Processing/Text Editing

1260 W. Foothill Blvd
Upland CA 91786
(714) 946-9908
(714) 941-7527

IMS INTERNATIONAL

Hardware: Microcomputers

3800 Lockhead Way
Carmen City NV 89008
(702) 883-7611

INCOM SYSTEMS

Software: Professional Services

1615 Sandpoint Way NE
Seattle WA 98115
(206) 527-8899

INFO DESIGNS

Software: Accounts Payable, Accounts Receivable,
General Ledger, Payroll/Personnel,
Sales/Distribution

6925 Telegraph Rd
Birmingham AL 35210
(215) 340-4910

INFORMATION BUILDERS

Software: Data Base Management

1220 Broadway
New York NY 10001
(212) 738-4433

THE INFORMATION PEOPLE

Software: Program Development/Debugging

440 Hudson Ave
Norwalk CT 06855
(614) 348-8644

INFORMATION UNLIMITED SOFTWARE (IUS)

Software: Accounts Payable, Accounts Receivable,
General Ledger, Integrated Accounting,
Sales/Distribution, Budgeting/Forecasting,
Word Processing/Text Editing, Data Base
Management

1401 Marshfield Way
San Jose CA 95128
(415) 371-6700

INFOSCRIBE

Hardware: Printers

2720 S Cuddy Way
Santa Ana, CA 92704
(714) 641-8225

INFOTEC

Hardware: Microcomputers

One Perimeter Rd
Manchester NH 03103
(603) 634-2700

INFOTEK

Hardware: Disks, Add-on Memory

1400 H. Barker St
Anaheim, CA 92804
(714) 954-3000

INFOTRON SYSTEMS

Hardware: Videos

Cherry Hill Industrial Center
Cherry Hill, NJ 08002
(609) 424-9400

INNOVATIVE SOFTWARE

Software: Graphics, Data Base Management

1000 W 110th St
Suite 380
Overland Park, KS 66210
(913) 365-1600

INNOVATIVE COMPUTER SYSTEMS & SOFTWARE

1801 Hopefield Road
Silver Spring, MD 20904
(301) 384-0337

INNOVATIVE SOFTWARE ASSOCIATES

Software: Professional Services

80 Wall Street
New York, NY 10005
(212) 403-2146

INSOFT

Software: Integrated Accounting, Data Base Management, Languages

10119 SW Harbor Blvd
Suite 200B
Portland, OR 97219
(503) 344-4100

INSTANT SOFTWARE

Software: Debugging/Recording

Pepperborough, NH 03461
(603) 924-9471

INSTRUMENTATION LABORATORY

Hardware: Microcomputers

First Div
One Barn Rd
Andover, MA 01810
(617) 470-1750

INTEGRAL DATA SYSTEMS

Hardware: Printers

Rt 13 S
Millard, NH 03081
(603) 673-9500

INTEGRATED BUSINESS COMPUTERS

Hardware: Microcomputers

10010 S Wilmington Ave
No. 306
Carmel, CA 93745
(213) 518-4245

INTEGREX

Hardware: Printers

233 N Juniper St
Philadelphia, PA 19107
(215) 348-9681

INTEL

Software: Operating Systems

Hardware: Microcomputers

3045 Bowser
Santa Clara, CA 95051
(408) 987-6000

INTELLIGENT SYSTEMS

Hardware: Microcomputers

221 Technology Pl
Menlo Park, CA 94025
(415) 440-2561

INTERACTIVE PICTURE SYSTEMS

Software: Graphics

270 Park Ave South
New York, NY 10010
(212) 407-7000

INTERACTIVE SYSTEMS TECHNOLOGY

Hardware: Microcomputers

5255 N Tacoma Ave
Suite 11
Indianapolis, IN 46220
(317) 252-1700

INTERNATIONAL DATA PROCESSING

Software: Professional Services

76 Floral Ave
Houma, LA 70364
(504) 884-6009

INTERNATIONAL MARKET RESOURCES

Software: Sales/Distribution

28 Garden Rd
Wellesley, MA 02151
(617) 231-6800

INTERNATIONAL MEMORIES

Hardware: Microsystem

10281 Randley Dr
Cupertino, CA 95014
(408) 446-5179

INTERNATIONAL MICRO SYSTEMS (IMS)

Software: Accounts Payable, Accounts Receivable, General Ledger, Payroll/Personnel, Job Costing, Integrated Accounting, Sales/Distribution, Professional Services, Word Processing/Text Editing

6445 Medical
Shawnee Mission, KS 66202
(913) 677-1137

INTERTEC DATA SYSTEMS

Hardware: Microcomputers

2300 Broad River Rd
Columbia, SC 29210
(803) 798-9700

INTERTECHNIQUE

Hardware: Microcomputers

26120 Platte
France
Telephone: (309)51-82.00

THE IPAC GROUP

Hardware: Microcomputers

PO Box 156
3047 Industrial Ave
Bethel Park, PA 15102
(412) 831-9300

IRWIN OLIVETTI

Hardware: Workstation

2800 Cayce Rd
Ann Arbor, MI 48106
(313) 643-9600

ISE

Software: Program Development/Debugging, Language

300 W Sagamore Pkwy
West Lafayette, IN 47906
(317) 462-4541

ITHACA INTERSYSTEMS

Hardware: Microcomputers, Address Modems

1600 Marshall Rd
Ithaca, NY 14850
(607) 252-0950

JERSEY MICRO SYSTEMS

Software: Integrated Accounting, Professional Services

12008 Hackensack Road
Cherry Hill, NJ 08032
(609) 424-2555

JINI MICRO-SYSTEMS

Software: Data Base Management

Box 274
Brook Park, OH 44132
(216) 796-6200

JOHNSON ASSOCIATES

Software: Utilities

PO Box 3866
Redding, CA 96003-3866
(916) 221-0740

JRT SYSTEMS

Software: Language

505 Irving St
San Francisco, CA 94122
(415) 564-5100

KAYCOMP COMPUTERS

Hardware: Microcomputers

533 Stevens Ave
Solana Beach, CA 92075
(714) 755-1334

KAYE INSTRUMENTS

Hardware: Printers

15 DeAngelo Dr
Bedford, MA 01730
(617) 275-0800

KELIX SOFTWARE SYSTEMS

Software: Engineering/Scientific

428 Denavesty Drive
Baton Rouge, LA 70802
(504) 766-6765

KENSINGTON MICROWARE

Software: Word Processing/Text Editing
919 Third Ave
New York NY 10022
(212) 486-1707

KEUFFEL & ESSER

Hardware: Microcomputers
1984 Jones Malinberger Rd
San Antonio TX 78214
(512) 822-4232

KEY SOFTWARE

Software: Data Base Management
2150 E. Denver Ave
Orem Plaines IL 60058
(312) 298-1610

KEY SYSTEMS

Software: Manufacturing
PO Box 13719
Manassas PA 17030
(202) 742-7402

LAND INNOVATION

Software: Engineering/Scientific
PO Box 59442
Dallas TX 75259-0642
(414) 254-8242

LEXISOFT

Software: Word Processing/Text Editing
PO Box 287
Davis CA 95616
(916) 758-2630

LIFEBOAT ASSOCIATES

Software: Budgeting/Forecasting, Engineering/Scientific,
Word Processing/Text Editing, Operating
Systems, Utilities, Program
Development/Debugging, Languages
1601 Third Avenue
New York NY 10028
(212) 865-0300

LIFETREE SOFTWARE

Software: Word Processing/Text Editing
177 Webster
Suite 342
Monterey CA 93940
(408) 499-9501

LINBERGH SYSTEMS

Software: Data Communications
41 Fairhill Rd
Holdsen MA 01528
(617) 852-0223

LINK SYSTEMS

Software: Data Communications
1840 19th Street
Santa Monica CA 90404
(310) 453-1851

LJK ENTERPRISES

Software: Data Base Management
PO Box 10827
St. Louis MO 63129
(314) 942-1852

LNW COMPUTERS

Hardware: Microcomputers
2620 Walnut Ave
Ruston CA 92680
(714) 944-5744

LOGICA

Software: Data Communications
646 Third Ave 19th Floor
New York NY 10017
(212) 579-0828

LOGICAL SYSTEMS

Software: Word Processing/Text Editing, Operating
Systems, Utilities
11300 N. First Washington Rd
Nashvorn WI 53052
(414) 241-2066

LOTUS DEVELOPMENT

Software: Budgeting/Forecasting, Graphics
160 First St
Cambridge MA 02142
(617) 452-7071

LOVELLS

Software: Data Communications
4225 Wilshire
Cypress-Clarens TX 75412
(214) 852-3096

M HUDIS & ASSOCIATES

Software: Engineering/Scientific
1280 Professional Drive
Santa Rosa CA 95401
(707) 542-6792

M/A-COM OFFICE SYSTEMS

Hardware: Microcomputers
7 Oak Park
Bedford MA 01730
(617) 275-4442

MAD COMPUTER

Hardware: Microcomputers

3390 Sloat Blvd Bldg 13
Santa Clara CA 95051
(408) 980-0840

MADWEST SOFTWARE

Software: Graphics

PO Box 9622
Madison WI 53713
(608) 238-4875

MAIL/BASIC FOUR

Hardware: Microcomputers

Information Systems Div
19401 Myford Rd
Tustin CA 92680
(714) 701-5100

MANAGEMENT & COMPUTER SERVICES

Software: Budgeting/Forecasting

Coast Valley Corporate Center
Valley Forge PA 19402
(215) 648-0750

MANNESMANN TALLY

Hardware: Printers

6001 S. 180th St
Kent WA 98041
(206) 231-5900

MANX SOFTWARE SYSTEMS

Software: Languages

PO Box 35
Stambury NJ 07701
(201) 768-8504

MAP SYSTEMS

Software: Utilities

1120 NASA Road One
Suite 444
Houston TX 77058
(713) 333-8640

MARC SOFTWARE INTERNATIONAL

Software: Word Processing/Test Editing

280 Sheridan Avenue
Suite 200
Folsom CA 95630
(415) 328-1971

MARK OF THE UNICORN

Software: Word Processing/Test Editing

PO Box 403
Arlington MA 02114
(617) 489-1347

MARKETING ESSENTIALS

Software: Program Development/Debugging

306 Mother Avenue
Woodburn NY 11798
(800) 445-2622

MATEC INTERNATIONAL ELECTRONICS

Hardware: Microcomputers

20 Williams St
Wellesley MA 02151
(617) 337-2115

MATROX ELECTRONIC SYSTEMS

Hardware: Microcomputers, Add-on Memories

5800 Ardmore Ave
T M R Montreal H4T 1H4
Canada
(514) 735-1162

MCC SOFTWARE

Software: Sales/Distributions, Budgeting/Forecasting,
Professional Services, Word Processing/Test
Editing

12911 Merle Hwy Rd
PO Box 180
Johnston IA 50131
(319) 276-3347

MCCINTOCK

Software: Professional Services

9601 South Ocean Hwy
PO Box 430880
Miami FL 33143
(305) 444-1308

DANN MCCREARY SOFTWARE

Software: Data Communications

PO Box 16405
San Diego CA 92116
(714) 743-5041

MCCULLOUGH & ASSOCIATES

Software: Manufacturing

1401 N. Jesse Jones Rd
Excelsior Springs MO 64124
(816) 627-6638

MCM COMPUTERS

Hardware: Microcomputers

133 Dalton St
Kingston ON K7L 4W2
Canada
(613) 544-9960

MC MILLAN COMPUTING SERVICES

Software: Program Development/Debugging
PO Box 42
Reading RG2 5BF
England
(073) 441-4791

MEMODYNE

Hardware: Printers
330 Reservoir St.
Hudson Heights MA 02154
(617) 444-7000

MEMOREX

Hardware: Micro/terminals
San Thomas & Central Express
Santa Clara CA 95051
(408) 987-1800

MERCATOR BUSINESS SYSTEMS

Hardware: Microcomputers
1294 Lawrence Station Rd
Sunnyvale CA 94086
(408) 734-9124

METASOFT

Software: Word Processing/Text Editing
711 E. Cottonwood
Suite II
Casa Grande AZ 85302
(602) 826-0268

MICRO APPLICATIONS GROUP

Software: Data Base Management, Utilities
20221 Sherman Way
Suite 205
Carpaga Park CA 91306
(714) 760-1406

MICRO BUSINESS SOFTWARE (MBSI)

Software: Accounts Payable, Accounts Receivable,
General Ledger, Payroll/Personnel,
Sales/Distribution
Dover Rd
Willow Hill Bldg
Chichester NH 03033
(603) 799-5700

MICRO BUSINESS SYSTEMS

Software: Professional Services, Manufacturing
7725 Broadway
Suite II
Marinville IN 46410
(219) 760-3440

MICRO CONTROL SYSTEMS

Software: Graphics
143 Tunnel Rd
Wormon CT 06094
(203) 475-0602

MICRO DATA BASE SYSTEMS

Software: Data Base Management
620 S. Bell Avenue
PO Box 348
Lafayette IN 47904
(317) 440-1806

MICRO DATA BUSINESS FORMS & SYSTEMS

Software: Accounts Payable, Accounts Receivable,
General Ledger, Payroll/Personnel, Job Costing,
Integrated Accounting, Sales/Distribution,
Professional Services
2307 Lacey Blvd
#104
Olympia WA 98502
(206) 459-0300

MICRO FIVE

Hardware: Microcomputers
17791 Sky Park Circle
Irvine CA 92714
(714) 257-1217

MICRO FOCUS

Software: Program Development/Debugging
1401 Clinic Center Dr
Santa Clara CA 95050
(408) 240-7006

MICRO MANUFACTURING SYSTEMS

Software: Manufacturing
187 Shagbark
Wasserville OH 43081
(614) 885-0738

MICRO METRIC

Software: Word Processing/Text Editing
111 E. St
Box 38
Davis CA 95616
(916) 758-0330

MICRO PERIPHERALS

Hardware: Monitors, Disettes
5754 Deering Ave
Channahon IL 61011
(312) 709-0300

MICRO SOURCE

Hardware: Microcomputers

PO Box 318
New Lebanon OH 45345
(513) 467-1285

MICRO SYSTEMS SOFTWARE

Software: Data Communications

4501-18 Oak Circle
Boca Raton FL 33437
(305) 985-0790

MICRO TECHNOLOGY

Hardware: Computers

1126-G Katella Ave
Orange CA 92667
(714) 771-1642

**MICRO TECHNOLOGY
UNLIMITED**

Hardware: Microcomputers

PO Box 12706
2806 Hillsborough St
Raleigh NC 27605
(919) 833-1488

MICRO-SO

Hardware: Computers

2156 S Hathaway St
Santa Ana CA 92705
(714) 731-9461

MICRO-WARE DISTRIBUTORS

Software: Graphics

PO Box 115
Pompano Beach FL 33064
(305) 839-3425

MICROAPL LTD

Hardware: Microcomputers

19 Catherine Pl
Victoria, London
England SW91T 6DX
Telephone: 01-454-3687 x8

MICROBAR SYSTEMS

Hardware: Microcomputers

1120 San Antonio Rd
Folsom CA 95630
(415) 964-2662

MICROCOM

Software: Data Communications

1480 A Providence Hwy
Newport MA 02847
(617) 762-0210

**MICROCOMPUTER
CONSULTANTS**Software: Accounts Payable, Accounts Receivable,
General Ledger, Sales/Distribution

PO Box 1337
Davis CA 95617
(800) 854-5952 (outside CA)
(916) 756-8104 (inside CA)

MICROCOMPUTER SYSTEMS

Hardware: Workstations

433 Lakeside Dr
Sunnyvale CA 94086
(408) 733-4200

MICROMATION LTD

Software: Word Processing/Text Editing

1 Yorkdale Rd
Suite 408
Toronto Ontario M6A3A1
Canada

MICROMOTION

Software: Graphics

12077 Wilshire Blvd
Suite 306
Los Angeles CA 90025
(213) 421-4340

MICROPERIPHERAL

Hardware: Modules

2565 152nd Ave NE
Bellevue WA 98005
(206) 861-7344

MICROPOLIS

Hardware: Computers

20228 Hordhoff St
Chesapeake VA 21031
(303) 799-0300

MICROPRO INTERNATIONALSoftware: Budgeting/Forecasting, Graphics, Word
Processing/Text Editing, Data Base
Management, Utilities

30 San Pablo Ave
San Rafael CA 94033
(415) 499-1280

MICROPROCESSOR SYSTEMS

Hardware: Printers

215 Caroline Dr
Maitland FL 32751
(305) 854-3260

MICROSOFT

Software: Budgeting/Forecasting, Word Processing/Text Editing, Operating Systems, Languages
Hardware: Add-on Memories

10700 Northrup Way
Bellevue WA 98004
(206) 835-8080

MICROSTUF

Software: Data Communications

1700 Leland Drive
Suite 12
Mar Vista CA 90267
(404) 152-0267

MICROTECH BUSINESS SYSTEMS

Hardware: Workstations

27100 Pyramus St
Costa Mesa CA 92626
(714) 557-8640

MICROTECH EXPORTS

Software: Utilities

467 Hamilton Avenue
Suite 2
Palo Alto CA 94301
(415) 324-9714

MICROTEK

Hardware: Add-on Memories

9554 Chesapeake Dr
San Diego CA 92121
(714) 278-0653

MIDWEST COMPUTER CENTER

Software: Accounts Payable, Accounts Receivable, General Ledger, Payroll/Personnel, Job Costing, Manufacturing

3785 Morris Hwy Road
Joliet IL 60531
(312) 276-3367

MILES COMPUTING

Software: Payroll/Personnel

7126 Haskell Ave
Van Nuys CA 91406
(213) 766-6297

MILLER MICROCOMPUTER SERVICES

Software: Languages

40 Lake Shore Rd
Hagah MA 01760
(617) 423-8736

MINISCRIBE

Hardware: Workstations

400 S Sunset
Longmont CO 80501
(303) 451-6200

MISOSYS

Software: Graphics, Utilities, Program Development/Debugging

5904 Edgemoor Dr
Alexandria VA 22303
(703) 760-2700

MOLECULAR COMPUTER

Software: Data Base Management

Hardware: Microcomputers

1885 Zanker Rd
San Jose CA 95112
(408) 966-5440

MONOLITHIC SYSTEMS

Hardware: Add-on Memories

4 Inverness Circle East
Englewood CO 80112
(303) 770-7400

MONROE SYSTEMS

Software: Data Communications

Hardware: Microcomputers

The American Rd
Morris Plains NJ 07950
(201) 540-7300

MORGAN-FAIRFIELD GRAPHICS

Software: Graphics

4234-A University Way NE
Seattle WA 98105
(206) 622-1274

MORROW DESIGNS

Hardware: Microcomputers, Add-on Memories

9221 Central Ave
Richmond CA 94804
(415) 524-2101

MOTOROLA

Hardware: Microcomputers

Box 20712
3005 E McDowell Rd
Phoenix AZ 85026
(602) 344-5739

MPC PERIPHERALS

Hardware: Add-on Memories

401 Chesapeake Dr
San Diego CA 92121
(619) 278-0653

MPS COMPANY

Software: Engineering/Scientific

8 North Grant Drive
 Addison IL 60101
 (312) 543-1746

MPSI (MICRO-COBOL PRODUCTS)

Software: Accounts Receivable, Word Processing/Text Editing, Operating Systems, Languages

2475 E Bayshore Rd
 Suite 340
 Palo Alto CA 94303
 (415) 854-3582

MULTI-TECH SYSTEMS

Hardware: Microcomputers, Modems

82 Second Ave SE
 Near Brighton MA 02112
 (617) 671-0580

MULTISOFT

Software: Graphics

14025 SW Farmington Rd
 Beaverton OR 97005
 (503) 325-4750

MULTISOFT

Software: Data Base Management

125 E 88th St
 New York NY 10028
 (212) 324-8600

MULTITECH ELECTRONICS

Hardware: Microcomputers

185 W B Camino Real
 Sunnyvale CA 94085
 (408) 779-8400

MUSE SOFTWARE

Software: Word Processing/Text Editing

347 H Charles St
 Baltimore MD 21201
 (301) 459-7212

MYCROFT LABS

Software: Data Communications

PO Box 6645
 Tallahassee FL 32301
 (904) 382-2708

NATIONAL SEMICONDUCTOR

Hardware: Microcomputers

2900 Semiconductor Dr
 Santa Clara CA 95051
 (408) 737-3000

NCR

Hardware: Microcomputers

1000 S Patterson Blvd
 Dayton OH 45409
 (513) 443-2075

NEC INFORMATION SYSTEMS

Hardware: Microcomputers, Workstations, Modems

5 Millis Dr
 Lexington MA 02173
 (617) 862-2120

NEPENTHE PROGRAMS

Software: Sales/Distribution

44 Third Ave
 Suite F
 Chula Vista CA 92010
 (714) 423-5881

NESTAR SYSTEMS

Software: Budgeting/Forecasting, Data Communications

Hardware: Microcomputers

2385 E Bayshore Rd
 Palo Alto CA 94303
 (415) 455-2225

NEW WORLD COMPUTER

Hardware: Workstations

3176 Pullman St
 Suite 120
 Costa Mesa CA 92626
 (714) 558-5120

NF SYSTEMS

Software: Data Communications

PO Box 70363
 Atlanta GA 30358
 (404) 252-1800

NHC ELECTRONICS

Hardware: Microcomputers

15031 Computer Lane
 Huntington Beach CA 92648
 (714) 870-8008

NORDELL DATA SYSTEMS

Software: Word Processing/Text Editing

3400 Wilshire Blvd
 Los Angeles CA 90010
 (213) 251-2028

NORTH AMERICA MICA

Software: Budgeting/Forecasting

10772 Sorrento Valley Rd
 San Diego CA 92121
 (714) 481-6088

NORTH STAR COMPUTERS

Hardware: Microcomputers

1440 Cassalia Street
San Leandro CA 94577
(415) 357-8500

NORTHERN TELECOM

Hardware: Microcomputers

PO Box 1223
Minneapolis MN 55402
(612) 352-8376

NORTHWEST ANALYTICAL

Software: Budgeting/Forecasting

1532 SW Morrison St.
Portland OR 97205
(503) 224-7727

NOVATION

Hardware: Modems

3840 Franks St.
Chattworth CA 91311
(213) 946-5080

NU DATA

Hardware: Modems

32 Fairview Ave.
Little Silver NJ 07729
(201) 842-3757

NUMERITRONIX

Hardware: Microcomputers

2580 Abshire Circle
Newbury Park CA 91320
(805) 499-2640

OASIS SYSTEMS

Software: Word Processing/Text Editing

2765 Raymond Way
San Diego CA 92161
(714) 291-9459

**OCCUPATIONAL COMPUTING
COMPANY (OCC)**

Software: General Ledger, Payroll/Personnel, Integrated Accounting, Professional Services

22311 Van Ness Blvd.
Suite 129
Woodland Hills CA 91364
(213) 999-1999

OHIO DATA BASE

Software: Professional Services, Word Processing/Text Editing

4422 W 21st
No 1
Cleveland OH 44126
(216) 552-5023

OKIDATA

Hardware: Printers

101 Galtier Dr.
Mt Laurel NJ 08054
(609) 278-2600

OLIVETTI

Hardware: Microcomputers, Printers

125 White Plains Rd.
Tarrytown NY 10591
(914) 631-6900

OLYMPIA USA

Hardware: Microcomputers, Printers

Rt 22
PO Box 22
Somerville NJ 08876
(201) 712-7800

OLYMPIC SYSTEMS

Software: Manufacturing

410 Macdon Ave.
Santa Rosa CA 95405
(707) 526-1294

OLYMPUS SOFTWARE

Software: Budgeting/Forecasting

644 Elizabeth St.
Salt Lake City UT 84102
(801) 582-5202

OMEGA MICROWARE

Hardware: Add-on Modules

222 S Riverside Plaza
Chicago IL 60606
(312) 648-6844

OMICRON SOFTWARE

Software: Graphics

Suite 290 Bldg 37
Executive Pk 3 NE
Atlanta GA 30329
(404) 325-6124

OMNIBYTE

Hardware: Microcomputers

245 W Roosevelt Rd.
Bldg 1 Unit 5
West Chicago IL 60185
(312) 321-6880

OMNITEC DATA

Hardware: Modems

2425 S 20th St.
Phoenix AZ 85024
(602) 328-6423

OMITOO

Software: Languages

212 Bacon St
Waltham, MA 02154
(617) 899-3900

ON-LINE INSTRUMENT SYSTEMS

Software: Engineering/Scientific

Route 2
Box 2754
Jefferson, CA 92646
(804) 367-0997

ONTEL

Software: Word Processing/Text Editing
Hardware: Microcomputers

280 Greenway Park Dr
Woodbury NY 11797
(516) 364-2121

ONYX SYSTEMS

Software: Languages

Hardware: Microcomputers

73 E. Triunfo Rd
San Jose, CA 95131
(408) 946-6200

OPEN SYSTEMS

Software: Accounts Payable, Accounts Receivable,
General Ledger, Payroll/Personnel, Job Costing,
Sales/Distribution

438 Oak Grove
Suite 409
Minneapolis, MN 55403
(612) 870-2015

OSBORNE COMPUTER

Hardware: Microcomputers

26500 Corporate Ave
Hayward, CA 94545
(415) 887-8060

OSBORNE/MCGRAW HILL

Software: Budgeting/Forecasting

600 Bancroft Way
Berkeley, CA 94710
(415) 548-3805

OSM COMPUTER

Hardware: Microcomputers

2264 Walsh Ave
Santa Clara, CA 95051
(408) 458-8910

OTRONA

Hardware: Microcomputers

4780 Walnut St
Boulder, CO 80501
(303) 444-8100

OWL SOFTWARE

Software: Word Processing/Text Editing

8927 Acolt Ave
North Hollywood, CA 91605
(213) 982-4248

PACSOFT

Software: Engineering/Scientific

735 Seventh Ave
Kirkland, WA 98033
(206) 827-0001

PANASONIC

Software: Utilities

Hardware: Microcomputers, Printers

One Panasonic Way
Secaucus, NJ 07094
(201) 348-7000

PARAMETRICS

Software: Engineering/Scientific

1125 W Oak
In Collins, CO 80521
(303) 320-2940

PASCAL SYSTEMS

Software: Data Base Management

608 Menlo Ave
Suite 909
Menlo Park, CA 94025
(415) 325-0766

PEACHTREE SOFTWARE

Software: Accounts Payable, Accounts Receivable,
General Ledger, Payroll/Personnel,
Sales/Distributions, Budgeting/Forecasting,
Graphs, Word Processing/Text Editing

2445 Peachtree Rd NE
Atlanta, GA 30336
(404) 262-2276

PEBX

Hardware: Add-on Modules

501 Vandell Way
Campbell, CA 95828
(408) 266-7800

PEGASUS DATA SYSTEMS

Hardware: Microcomputers

234 Lockland Dr
Middlesex, NJ 08946
(201) 666-6707

PERFECT SOFTWARE

Software: Budgeting/Forecasting, Word Processing/Text
Editing, Data Base Management

1400 Shattuck Ave
Berkeley, CA 94709
(415) 644-3201

PERICOMP SYSTEMS

Software: Accounts Payable, Accounts Receivable,
Integrated Accounting, Sales/Distribution
7 Ellis Dr
Hastock MA 01940
(617) 451-1460

PERKIN-ELMER

Hardware: Microcomputers
3 Crescent Pl
Crosspoint NJ 07017
(201) 870-6712

PERSONAL MICRO COMPUTERS

Hardware: Microcomputers, Databases
475 Ellis Street
Mountain View CA 94040
(415) 962-0230

PERTEC COMPUTER

Hardware: Microcomputers
17332 Von Karman Ave
PO Box 11600
Irvine CA 92714
(714) 540-8240

PHASE ONE SYSTEMS

Software: Budgeting/Forecasting, Operating Systems
1700 Edgewater Dr
Suite 800
Oakland CA 94621
(415) 562-8005

PHC

Hardware: Microcomputers
PO Box 1108
21 Merty Dr
Aven Arden Md 48606
(313) 994-0501

**PHILADELPHIA CONSULTING
GROUP**

Software: Data Communications
PO Box 140
Wynnewood PA 19086
(215) 449-1598

PHILIPS DATA SYSTEMS

Hardware: Microcomputers
PO Box 248
Apeldoorn
The Netherlands
Telephones: (053-120121)

PK SYSTEMS

Software: Professional Services
182 N. Center St
Bloomington IL 61801
(312) 339-6611

PLENARY SYSTEMS

Hardware: Microcomputers
9600 Wendell Rd
Dallas TX 75243
(754) 343-9901

PLESSEY MICROSYSTEMS

Hardware: Winchester, Add-on Memory
451 Hungerford Dr
Rockville MD 20850
(301) 279-2850

**PLESSEY PERIPHERAL SYSTEMS
COMPUTER PRODUCTS DIV**

Hardware: Address Memory
1624 McCune Ave
Irvine CA 92714
(714) 540-9945

POINT 4 DATA

Software: Operating Systems
Hardware: Microcomputers
3560 McCube Way
Irvine CA 92714
(714) 862-1111

POLARIS MICROCOMPUTERS

Hardware: Microcomputers
6000 Hinklel Ave
Van Nuys CA 91406
(213) 989-5111

PRACTICAL AUTOMATION

Hardware: Planners
Temp Kelly Rd
Shelton CT 06484
(203) 929-5381

PRECISION VISUALS

Software: Graphics
6368 Lookout Rd
Boulder CO 80501
(303) 520-9000

PREDIX

Software: Data Communications
1345 Avenue of the Americas
New York NY 10019
(212) 677-0990

PRENTICE

Hardware: Modems
204 Caplan Dr
Sunnyvale CA 94086
(408) 734-9810

PRINTER PRODUCTS

Hardware: Printers

34 Centry Rd.
Allison, MA 02134
(617) 767-0880

PRINTERS SOFTWARE

Software: Sales/Distribution

100 Route 29 South
Pompton Plains, NJ 07864
(201) 826-6797

PRODIGY SYSTEMS

Software: Accounts Receivable, Payroll/Personnel

487 Lincoln Hwy.
Teaneck, NJ 07660
(201) 261-2000

PRODUCT ASSOCIATES

Hardware: Microcomputers

440 Convention Way
Redwood City, CA 94063
(415) 364-3121

PROFESSIONAL BUSINESS COMPUTER SYSTEMS

Software: Sales/Distribution, Manufacturing

10015 N. Scottsdale Road
Scottsdale, AZ 85215
(602) 948-5772

PROFESSIONAL COMPUTER SERVICES

Software: Professional Services

524 Cooke St.
Honolulu, HI 96813
(808) 367-6042

PROFESSIONAL SOFTWARE

Software: Professional Services, Word Processing/Text Editing

31 Fenwick St.
Needham, MA 02454
(617) 444-5224

PROGRAMMED SYSTEMS

Software: Professional Services

16 Ragby Dr.
Suite 305
Birmingham, AL 35209
(205) 938-4134

PYRAMID DATA LTD

Software: Duplicating/Processing

PO Box 10156
Santa Ana, CA 92711
(714) 439-1327

QANTEX

Hardware: Peripherals

40 Flair Ave.
Hempstead, NY 11764-3880
(516) 342-4040

QUADRAM

Hardware: Add-on Memories

4357 Park Dr.
Horrocks, CA 95031
(404) 923-6666

QUANTUM

Hardware: Winchester

1804 McCarthy Blvd.
Milpitas, CA 95035
(408) 262-1180

QUANTUM COMPUTER SYSTEMS LTD

Hardware: Microcomputers

40-62 The Balcony, Meridian Centre
London
England LS2 8WJ
Telephone: (0532)458877

QUARK ENGINEERING

Software: Word Processing/Text Editing

1403 Williams
Suite 1000
Denver, CO 80218
(303) 734-2211

QUASAR DATA PRODUCTS

Hardware: Microcomputers

10000 Brecksville Rd.
Cleveland, OH 44131
(216) 326-0838

QUASITRONICS

Hardware: Add-on Memories

211 Vindale Dr.
Houston, TX 77243
(713) 749-2662

QUAY

Hardware: Microcomputers

227 Industrial Way W
PO Box 710
Edison, NJ 07024
(201) 542-7340

QUELO

Software: Program Development/Debugging

845 NW 54th
Seattle, WA 98107
(206) 764-6918

R&E COMPUTER SYSTEMS

Software: Professional Services

648 South River Drive
Tempe AZ 85281
(602) 968-7500

R&L SOFTWARE

Software: Engineering/Scientific

1299 Beacon Street
Newton MA 02459
(617) 554-0992

RABBIT SOFTWARE

Software: Data Communications

1 Great Valley Pkwy. East
Malvern PA 19353
(215) 662-0440

RACAL-DANA

Hardware: Minicom

4 Cavendish St. 92714
PO Box C-17840
Irvine CA 92713
(714) 855-8946

RACAL-VADIC

Hardware: Modems

222 Caspan Dr
Bannockburn IL 60015-1074
(800) 744-0810

RAINBOW COMPUTING

Software: Graphics

19317 Business Center Dr
Northridge CA 91324
(213) 341-0300
(800) 421-9491

RAIR

Hardware: Microcomputers

4908 Burton Dr
Santa Clara CA 95050
(408) 985-1790

RAIR LTD

Hardware: Microcomputers

4-8 Upper St. Martins Ln
London
England WC2H 0EQ
Telephones: 01-463-9631

REALWORLD SOFTWARE

Software: Word Processing/Text Editing

9713 South Fourth St
Suite 103
DeKalb IL 60115
(312) 759-4476

REDDING GROUP

Software: Graphics

408 Main St
Ridgefield CT 06877
(203) 431-8841

REGENCY SYSTEMS

Hardware: Microcomputers

PO Box 3590
6650 Interstate Dr
Champaign IL 61820
(312) 398-0067

**RELATIONAL SYSTEMS
INTERNATIONAL**

Software: Utilities, Program Development/Debugging

PO Box 12892
Salem OR 97306
(503) 340-8929

REMEX

Software: Engineering/Scientific

Hardware: Software

6285 28th St SE
Suite A
Grand Rapids MI 49508
(616) 942-9800

RESTON PUBLISHING

Software: Graphics

7140 Sunset Hills Rd
Reston VA 22060
(703) 427-8900

RIXON

Hardware: Hardware

2120 Industrial Pkwy
Silver Springs MD 20904
(301) 662-2121

RODIME

Hardware: Workstations

28001 Otters
Suite B
Mission Viejo CA 92691
(714) 776-3000

ROTATING MEMORY SYSTEMS

Hardware: Workstations

1701 McCarthy Blvd
Milpitas CA 95036
(408) 948-6600

RYAN-MCFARLAND

Software: Languages

426 Deep Valley Dr
Rolling Hills Estates CA 90274
(213) 341-4826

RZE OF AMERICA

Hardware: Microcomputers

2948 W. County Rd. C
Roseville, MA 02113
(617) 438-2900

SAGE COMPUTER TECHNOLOGY

Hardware: Microcomputers

4905 Energy Way
Beverly, NY 09602
(702) 322-6868

SANYO BUSINESS SYSTEMS

Hardware: Microcomputers, Peripherals

St. Joseph St.
Morristown, NJ 07954
(201) 440-9300

SATELLITE SOFTWARE INTERNATIONAL

Software: Word Processing/Text Editing

280 W. Center St.
Green, UT 84037
(801) 224-6054

SATURN SYSTEMS

Software: Budgeting/Forecasting

Hardware: Addition Peripherals

P.O. Box 8030
Ann Arbor, MI 48107
(313) 973-6422

SICC & ELCO SYSTEMS

Software: Professional Services, Manufacturing

13342 Sunset Place
Santa Ana, CA 92705
(714) 731-6558

SCENIC COMPUTER SYSTEMS

Software: Word Processing/Text Editing

Hardware: Microcomputers

14853 NE 31st Circle
Redmond, WA 98052
(206) 882-1580

SCI SYSTEMS

Hardware: Microcomputers

5000 Technology Drive
P.O. Box 7000
Huntsville, AL 35897
(205) 882-4800

SCI-COM COMPUTER SYSTEMS

Hardware: Microcomputers

581 Rte. 22
P.O. Box 6050
Bridgewater, NJ 08807
(201) 662-0270

SCIENTIFIC DATA SYSTEMS

Hardware: Microcomputers

344 Main Street
Venice, CA 90291
(213) 290-8673

SCIENTIFIC MICRO SYSTEMS

Hardware: Microcomputers, Peripherals

777 E. Middlefield Rd.
Mountain View, CA 94033
(415) 964-3700

SD SYSTEMS

Hardware: Microcomputers

1011 Miller Rd.
P.O. Box 38810
Dallas, TX 75238
(214) 340-0203

SEAGATE TECHNOLOGY

Hardware: Winchester

340 El Pueblo Rd.
Sunnyvale, CA 95088
(408) 438-4350

SEATTLE COMPUTER PRODUCTS

Hardware: Microcomputers, Addition Peripherals

7714 Industry Dr.
Seattle, WA 98148
(206) 525-1830

SEEQUA COMPUTER

Hardware: Microcomputers

208 West St.
Annapolis, MD 21401
(301) 268-6850

SELANAR

Software: Graphics

407-Aldo Ave.
Santa Clara, CA 95050
(408) 722-2811

SELECT INFORMATION SERVICES

Software: Word Processing/Text Editing

985 St. Francis Drake Blvd.
Kensfield, CA 95824
(415) 459-6000

SELVA SYSTEMS

Software: Graphics

147 Worcester St.
Wellesley, MA 02157
(617) 421-7376

SEMI-DISK SYSTEMS

Hardware: Address Memory

PO Box 602
Beaverton OR 97005
(503) 642-3700

SENDERO

Software: Professional Services

4805 N 14th Pl
Phoenix AZ 85014
(602) 279-0400

SENTINEL COMPUTER

Hardware: Printers

5000 Conner Rd
Cincinnati OH 45242
(618) 984-6622

SHAFFER & SHAFFER APPLIED RESEARCH & DEVELOPMENT

Software: Budgeting/Forecasting

2468 N High St
Columbus OH 43214
(614) 267-2700

SHAKTI SYSTEMS

Software: Data Base Management

PO Box 98243
Schaumburg IL 60194
(312) 480-0501

SHARP ELECTRONICS

Hardware: Microcomputers

10 Kynessie Pl
Paramus NY 07652
(201) 265-0600

SHUGART

Hardware: Workbooks, Databases

433 Oakmead Pkwy
Sunnyvale CA 94086
(408) 732-0100

SIERRA NATIONAL

Hardware: Microcomputers

3237 Buffner St
San Diego CA 92111
(714) 277-4800

SIERRA ON-LINE

Software: Word Processing/Test Siding

Sierra On-Line Building
Countryside CA 91614
(201) 482-0800

SILICON VALLEY

Software: Word Processing/Test Siding

1625 El Camino Real #14
Belmont CA 94002
(415) 393-0344

SIMULATED COMPUTER PRODUCTS

Software: Word Processing/Test Siding

4807 E Speedway Blvd
Tucson AZ 85712
(602) 322-0091

SINCLAIR OPTICS

Software: Engineering/Scientific

20 N Main Street
Pittsford NY 14254
(716) 381-9100

SINCLAIR RESEARCH

Hardware: Microcomputers

Starhope Rd
Cambridge Surrey
0229-485071

SINGLE SOURCE SOLUTION

Software: Professional Services

2095 Clayton Rd
Concord CA 94029
(415) 480-0002

SMALL BUSINESS SYSTEMS GROUP

Software: Sales/Distribution, Data Communications

8 Carlisle Road
Westford MA 02086
(617) 450-3000

THE SMALL COMPUTER

Software: Data Base Management

40 W Ridgewood Ave
Ridgewood NJ 07450
(201) 445-5642

SMALL RECORDS ASSOCIATES

Software: Utilities

PO Box 302
Corte R. 90502
(714) 759-5270

SMC SOFTWARE SYSTEMS

Software: Operating Systems, Languages

1081 Route 22
PO Box 6800
Bridgewater NJ 08807
(201) 685-7000

SMITH-CORONA**Hardware: Nixos**

Consumer Products Div
48 Locust Ave
New Canaan CT 06840
(203) 973-1471

SNOKE SIGNAL BROADCASTING**Software: Budgeting/Forecasting****Hardware: Microcomputers, Add-on Memory**

11216 Via Colinas
Woodlake Village CA 91381
(213) 889-0540

SOFTSTAR**Software: Budgeting/Forecasting**

13103 US Hwy #1
Juno Beach FL 33408
(305) 427-9311

SOFSYS**Software: Word Processing/Text Editing**

4306 Upton Ave S
Minneapolis MN 55409
(612) 929-7194

SOFTCORP INTERNATIONAL**Software: Budgeting/Forecasting**

279 Huber Village Blvd
Westerville OH 43081
(614) 899-3920

SOFTTEAM**Software: Budgeting/Forecasting**

18003 1st Jefferson Blvd
Culver City CA 90230
(805) 421-0814

SOFTTECH MICROSYSTEMS**Software: Operating Systems, Language**

16085 W Bernardo Dr
San Diego CA 92127
(619) 471-1280

SOFTTEST**Software: Word Processing/Text Editing**

885 Gaille Rd
Edgewood NJ 07430
(201) 447-3821

SOFTRONICS**Software: Data Communications**

6426 Prince Edward
Manhasset NY 10919
(914) 753-5806

SOFTWARE ARTS**Software: Budgeting/Forecasting**

27 Maple Lane
Westbury MA 02181
(617) 337-8000

SOFTWARE CONNECTIONS**Software: Data Communications**

1800 Wycott Dr
Suite 17
Santa Clara CA 95054
(408) 985-3794

SOFTWARE DEVELOPMENT**Software: Utilities**

270 Avery Rd
Woodbridge CT 06525
(203) 387-0500

SOFTWARE DYNAMICS**Software: Word Processing/Text Editing**

2111 W Concept
Suite C
Anaheim CA 92801
(714) 433-4960

THE SOFTWARE EXPRESS**Software: Accounts Receivable**

10101 Foxden
Suite 230
Houston TX 77066
(800) 271-0062

THE SOFTWARE GROUP**Software: Program Development/Debugging**

18071 S Brookhurst St
Anaheim CA 92804
(714) 535-5274

SOFTWARE HOW'S**Software: Professional Services**

P.O. Box 34275
Los Angeles CA 90034
(213) 829-6793

SOFTWARE LIBRARIES**Software: Word Processing/Text Editing**

P.O. Box 844
Pasadena CA 91102
(213) 793-1700

**SOFTWARE MODULE
MARKETING****Software: Data Communications**

Crocker Bank Building/Penthouse
1007 Seventh St
Sacramento CA 95814
(800) 824-8512

SOFTWARE PRODUCTS INTERNATIONAL

Software: Accounts Receivable, Integrated Accounting, Budgeting/Forecasting, Professional Services, Data Base Management

10840 Roselle St
Suite A
San Diego CA 92121
(714) 450-1526

SOFTWARE PUBLISHING

Software: Graphics, Word Processing/Text Editing, Data Base Management

1901 Lindings Dr
Mountain View CA 94035
(415) 962-0700

SOFTWARE RESOURCES

Software: Budgeting/Forecasting, Professional Services, Graphics

188 Alameda Brook Parkway
Suite 310
Cambridge MA 02138
(617) 497-0500

SOFTWARE SORCERY

Software: Data Communications

7027 Jones Branch Dr
Suite 400
McLean VA 22102
(703) 355-2566

SOFTWARE SYSTEMS

Software: Word Processing/Text Editing

52 Oakland Ave N
East Hartford CT 06108
(203) 522-2114

THE SOFTWARE TOOLWORKS

Software: Budgeting/Forecasting, Word Processing/Text Editing

14076 Glenvista Drive
Sherman CA 94425
(203) 958-0814

SOLZBERG RESEARCH ASSOCIATES

Software: Manufacturing

3 Seabrook Court
Stony Brook NY 11790
(516) 751-4257

SONY

Hardware: Microcomputer

Microcomputer Products Division
7 Mercedes Dr
Morristown NJ 07960
(201) 575-8288

SORCIM

Software: Budgeting/Forecasting

405 Alida Dr
Santa Clara CA 95050
(408) 737-1634

SORD COMPUTER OF AMERICA

Software: Graphics

Hardware: Microcomputer

300 Park Ave
New York NY 10016
(212) 878-4400

SOUTHEASTERN SOFTWARE

Software: Data Communications

4914 Carlsbyline Drive
New Orleans LA 70126
(504) 246-8408

SOUTHWEST SYSTEMS

Software: Accounts Payable, Accounts Receivable, General Ledger, Payroll/Personnel, Job Costing, Integrated Accounting

44 Thirlot Ave
Suite 2
Chula Vista CA 92010
(714) 428-0500

SOUTHWESTERN DATA SYSTEMS

Software: Data Communications

PO Box 582
San Jose CA 95071
(714) 343-8670

SPECIAL DELIVERY SOFTWARE

Software: Budgeting/Forecasting, Professional Services

10240 Randall Dr
Cupertino CA 95014
(408) 954-1070

SPECTRA/SOFT

Software: Professional Services

PO Box 277
Chandler AZ 85224
(602) 960-6380

SSM MICROCOMPUTER

Software: Data Communications

Hardware: Address Memory

2150 Pagepple Dr
San Jose CA 95131
(408) 744-7400

SSR CORP

Software: Sales/Distribution

1400 Lynn Avenue
Rockledge FL 32955
(714) 254-1200

STAR COMPUTER GROUP

Software: Word Processing/Text Editing
 PO Box 3201
 Sharon PA 16046
 (412) 960-2913

STAR MICRONICS

Hardware: Processors
 200 Park Ave
 Pan Am Building Suite 2206
 New York NY 10046
 (212) 966-6770

STAR SOFTWARE SYSTEMS

Software: Integrated Accounting
 29000 Gateway Place
 Torrance CA 90501
 (310) 528-2511

STAR VALLE SOFTWARE

Software: Professional Services
 12218 Scribb Dr
 Austin TX 78759
 (512) 857-9498

STARSOFT

Software: Professional Services
 4884 El Camino Real
 Suite 128
 Los Altos CA 94022
 (415) 945-8000

STATE OF THE ART

Software: Accounts Payable, General Ledger,
 Payroll/Personnel, Sales/Distribution
 3881-A Airway Avenue
 Costa Mesa CA 92626-4468
 (714) 850-0913

STELLATION TWO

Hardware: Add-on Hardware
 Solano Blvd
 PO Box 2342
 Santa Barbara CA 93120
 (805) 966-7140

STM ELECTRONICS

Hardware: Microcomputers
 325 Maplefield Rd
 Suite 120
 Maitland FL 32751
 (407) 328-6776

STOK SOFTWARE

17 West 17th Street
 New York NY 10011
 (212) 363-1664

STONEWARE

Software: Graphics, Data Base Management
 50 Belvidere St
 San Rafael CA 94901
 (415) 459-8500

STRUCTURAL PROGRAMMING

Software: Graphics
 83 Boston Post Rd
 Sudbury MA 01776
 (617) 443-5386

STRUCTURED SYSTEMS GROUP (SSG)

Software: Accounts Payable, Accounts Receivable,
 General Ledger, Payroll/Personnel,
 Sales/Distribution, Budgeting/Forecasting,
 Word Processing/Text Editing, Data Base
 Management, Utilities
 3204 Claremont Ave
 Oakland CA 94618
 (415) 547-1507

STSC

Software: Languages
 2115 E Jefferson St
 Rockville MD 20852
 (301) 956-5000

SUNBELT COMPUTER SYSTEMS

Sunbelt Center
 2400 East 57th Street
 Tulsa OK 74105
 (918) 745-0706
 (800) 331-9565

SUPERSOFT

Software: Budgeting/Forecasting, Word Processing/Text
 Editing, Data Base Management, Data
 Communications, Utilities, Program
 Development/Debugging, Languages
 PO Box 1428
 Champaign IL 61820
 (317) 339-2012

SYKES DATATRONICS

Hardware: Microcomputers
 155 E Main St
 Rochester NY 14604
 (716) 325-9000

SYNAPSE SOFTWARE

Software: Utilities
 830 Coventry Road
 Kensington CA 94707
 (415) 827-7733

SYQUEST TECHNOLOGY

Hardware: Winchester

41440 Warm Springs Blvd
Fremont, CA 94538
(415) 490-7331

SYSTEM INTEGRATION ASSOCIATES

Software: Sales/Distribution, Professional Services, Operating Systems

Suite L-10 Great Valley Center
81 Lancaster Avenue
Malvern, PA 19355
(215) 296-1400

SYSTEMS GROUP

Hardware: Add-on Modules

1601 Chagrinwood Ave
Orange, CA 92668
(714) 633-4460

SYSTEMS PLUS

Software: Accounts Payable, Accounts Receivable, General Ledger, Integrated Accounting, Sales/Distribution, Budgeting/Forecasting, Professional Services, Data Base Management

1120 San Antonio Rd
Folsom, CA 95630
(415) 966-7647

THE SYSTEMS SHOPPE

Software: Professional Services

104 E. Main St
Greenwood, MD 21034
(301) 528-7627

TAB PRODUCTS

Hardware: Microcomputer

1401 California Ave
Folsom, CA 95630
(415) 858-2300

TALLGRASS TECHNOLOGIES

Hardware: Winchester

9207 Cody
Overland Park, KS 66211
(913) 349-3388

TANDATA

Hardware: Microcomputer

3204 E. 32nd St
Suite 6
Tulsa, OK 74133
(918) 742-2071

TANDEM

Hardware: Workstations, Databases

20000 Pebble St
Chousandale, CA 91311
(714) 960-6644

TANDY (RADIO SHACK)

Software: Budgeting/Forecasting, Professional Services, Engineering/Scientific, Graphics, Word Processing/Text Editing, Operating Systems, Data Base Management, Utilities

Hardware: Microcomputers, Peripherals

1800 One Tandy Center
Fort Worth, TX 76102
(817) 350-1500

TARANTO & ASSOCIATES

Software: Accounts Payable, Accounts Receivable, General Ledger, Integrated Accounting, Sales/Distribution

121 Paul Dr
San Rafael, CA 94903
(415) 452-2670

TARBELL ELECTRONICS

Software: Data Base Management

Hardware: Microcomputers

950 Devon Place
Suite B
Carson, CA 90746
(213) 536-0297

TCS SOFTWARE

Software: Accounts Payable, Accounts Receivable, General Ledger, Payroll/Personnel, Sales/Distribution, Professional Services, Manufacturing, Data Base Management

3208 Fondren Rd
Houston, TX 77063
(713) 937-1566

TEAC

Hardware: Diskettes

7750 Telegraph Rd
Northridge, CA 91340
(213) 736-0300

TECHNICAL DATA

Software: Professional Services

1 Federal St
Boston, MA 02108
(617) 482-3448

TECHNICAL SYSTEMS CONSULTANTS

111 Providence Rd
Chapel Hill, NC 27514
(919) 490-1451

TECMAR

Hardware: Add-on Memories

23600 Mercantile Rd
Cleveland OH 44123
(216) 484-2439

TEX-COM

Hardware: Modems

7142 Fargson Dr
San Jose CA 95121
(408) 263-1400

TEKTRONIX

Hardware: Microcomputers

PO Box 580
47180 SW Karl Braun Dr
Beaverton OR 97007
(503) 644-0161

TELEPHONE SOFTWARE CONNECTION

Software: Data Communications

PO Box 6248
Torrance CA 90504
(213) 574-9400

TELERAM COMMUNICATIONS

Hardware: Microcomputers

2 Corporate Park Dr
White Plains NY 10604
(914) 694-0070

TELETEK

Hardware: Add-on Memories

6967 F-Business Park Dr
Sacramento CA 95827
(916) 361-1771

TELEVIDEO SYSTEMS

Software: Budgeting/Forecasting

Hardware: Microcomputers

1170 Moore Ave
Sunnyvale CA 94086
(408) 749-7700

TENSECURITY

Software: Engineering/Scientific

2424 W Addison St
Chicago IL 60618
(312) 933-9714

TERAK

Hardware: Microcomputers

14051 N 76th St
Scottsdale AZ 85260
(602) 950-4800

TEXAS ELECTRONIC INSTRUMENTS

Software: Data Base Management

5075 S Loop East
Houston TX 77060
(713) 738-2338

TEXAS INSTRUMENTS

Software: Utilities

Hardware: Microcomputers, Minicomputers

PO Box 2909
Austin TX 78769
(512) 250-7161

TEXASOFT

Software: Languages

3415 Westheimer
Suite 180
Dallas TX 75205
(214) 366-0791

TEXPRINT

Hardware: Plotters

8 Blanchard Rd
Burlington MA 01803
(617) 273-5864

THE LWFW GROUP

Software: Professional Services

13700 Park Central
Suite 1805
Dallas TX 75261
(214) 233-5564

THOMAS SOFTWARE (TSC)

Software: Professional Services

1821 Sumac Rd
Suite 107
Cincinnati OH 45227
(513) 548-8700

THOUGHTWARE PUBLISHING

Software: Accounts Payable

PO Box 669
Grants Pass OR 97526
(503) 476-1467

3M

Hardware: Minicomputers

Business Communications Products
Div
3M Center
St Paul MN 55133
(612) 733-9572

THREE RIVERS COMPUTER

Hardware: Microcomputers

720 Gross St
Pittsburgh, PA 15224
(412) 627-6280

THRESHOLD SOFTWARE

Software: Engineering/Scientific

1812 Tribune Rd
Suite II
Sacramento CA 95815
(916) 922-8188

TIMBERLINE SOFTWARE

Software: Accounts Payable, Accounts Receivable,
General Ledger, Payroll/Personnel,
Budgeting/Forecasting

PO Box 25428
Portland OR 97223
(503) 643-9448

TIMEPLEX

Hardware: Modems

400 Chestnut Ridge Rd
Woodcliffe Lake NJ 07673
(201) 261-1111

TIPNIS

Software: Manufacturing

18865 Inverca Dr
Cincinnati OH 45247
(513) 791-3885

TMS/MSC

Software: Professional Services

2155 South 3275 West
Salt Lake City UT 84119
(801) 973-5800

TNW

Hardware: Modems

3448 Hancock St
San Diego CA 92110
(619) 286-2175

TORCH COMPUTERS LTD

Hardware: Microcomputers

Abberley House
Great Shelford Cambridge
England CB25QJ
Telephone: (0223) 641000

TOSHIBA AMERICA

Hardware: Microcomputers

2441 Michelle Dr
Irvine CA 92618
(714) 733-9300

TRAC LINE SOFTWARE

Software: Accounts Payable, Sales/Distribution,
Budgeting/Forecasting, Professional Services,
Manufacturing, Data Base Management

81 Alpha Plaza
Hicksville NY 11801
(516) 935-7300

TRENDATA/STANDARD MEMORIES

Hardware: Add-on Memories

3400 W Negamont Ave
Santa Ana CA 92704
(714) 540-3608

TREND/COM/3M

Hardware: Plotters

480 Oakmead Parkway
Sunnyvale CA 94086
(408) 730-0167

TRI-DATA

Hardware: Modems

625 E Middlefield Rd
Mountain View CA 94041
(415) 965-1700

TRIVECTOR COMMERCE LTD

Hardware: Microcomputers

Sunderland Rd
Sandy, Bedfordshire
England SG19 1BB
Telephone: 44 767 82222

TRONWARE

Software: Word Processing/Text Editing

3809 W 19th St
Overland Park KS 66205
(913) 381-0176

TRW-FUJITSU

Hardware: Microcomputers

1841 Algonk Blvd
Los Angeles CA 90048
(213) 643-0708

TUCK ELECTRONICS

Hardware: Modems

300 2nd St
New Cumberland PA 17050
(717) 761-6554

TYMSHARE

Hardware: Plotters

22825 Valley Green Rd
Cupertino CA 95014
(408) 448-6000

U.S. ROBOTICS

Hardware: Modems

1123 N. Washington
Chicago IL 60607
(312) 733-0877

UNIQUE INFORMATION SYSTEMS

Software: Professional Services, Engineering/Scientific

325 N. LaSalle St.
Suite 1320
Chicago IL 60601
(312) 332-2820

UNITED PERIPHERALS

Hardware: Disks/Drives

452 Lakeside Dr.
Sunnyvale CA 94086
(408) 730-4440

UNIVERSAL DATA SYSTEMS

Hardware: Modems

3300 Bradford Dr.
Huntsville AL 35893
(205) 837-8300

UYEON COMPUTER SYSTEMS

Software: Data Base Management

899 Logan St.
Denver CO 80203
(800) 325-1837

VADATA

Software: Integrated Accounting

17144 Midvale Ave. N.
Suite 907
Seattle WA 98133
(800) 436-5246
(206) 542-7821

VECTOR GRAPHIC

Software: Integrated Accounting, Budgeting/Forecasting,
Graphics, Word Processing/Text Editing, Data
Base Management, Data Communications

Hardware: Microcomputers, Printers

500 N. Venus Park Rd.
Thousand Oaks CA 91320
(805) 499-5837

VEN-TEL

Hardware: Hardware

2342 W. 18th Ave.
Santa Clara CA 95051
(408) 737-5721

VIA COMPUTER

Software: Budgeting/Forecasting

7107 Concession Ct.
San Diego CA 92121
(714) 578-5356

VICTOR BUSINESS PRODUCTS

Software: Word Processing/Text Editing

Hardware: Microcomputers

3800 N. Broadway St.
Chicago IL 60618
(312) 339-6200

VICTORY COMPUTER SYSTEMS

Hardware: Microcomputers

2885 Gateway Pl.
Suite 300
San Jose CA 95131
(408) 255-8800

VIHMAN

Software: Manufacturing

274 Main St.
Reading MA 01867
(617) 944-5787

J VILKAITUS CONSULTANTS

Software: Word Processing/Text Editing

417 High Street Ext.
Thomaston CT 06267
(203) 385-4333

VISICORP

Software: Job Costing, Budgeting/Forecasting,
Professional Services, Graphics, Word
Processing/Text Editing, Data Communications,
Utilities

3360 Zanker Road
San Jose CA 95134
(408) 948-8000

VISIONARY ELECTRONICS

Hardware: Hardware

141 Parker Ave.
San Francisco CA 94118
(415) 731-8211

VISTA COMPUTER

Hardware: Disks/Drives

1717 E. Edinger Ave.
Santa Ana CA 92705
(714) 953-8523

VM PERSONAL COMPUTING

Software: Data Communications

60 E. 42nd St.
New York NY 10018
(212) 697-4747

VOLUTION SYSTEMS

PO Box 1336
Ded Mar CA
(714) 481-2286

WANG LABORATORIES

Hardware: Microcomputers

One Industrial Ave
Lowell MA 01851
(617) 459-5200

WAVE MATE

Hardware: Microcomputers

14008 S Greenhew Blvd
Newtonville CA 95050
(213) 578-8500

WESTERN DIGITAL

Hardware: Microcomputers

2445 Alcazar Way
Irvine CA 92714
(714) 557-3300

WESTERN DYNEX

Hardware: Microcomputers

3136 W Calvert Rd
Phoenix AZ 85019
(602) 359-6401

WESTERN ELECTRIC

Software: Operating Systems

PO Box 25000
Cincinnati OH 45220
(513) 497-2000

**WESTERN SOFTWARE
DEVELOPMENT**

Software: Word Processing/Text Editing

PO Box 953
Woodland Park CO 80063
(303) 487-2317

WESTICO

Software: Budgeting/Forecasting, Data Communications

25 Van Zant St
Norwalk CT 06851
(203) 453-6880

WESTMINSTER SOFTWARE

Software: Budgeting/Forecasting

2000 Sand Hill Rd
Rt 4 Suite 345
Menlo Park CA 94025
(415) 854-1400

WHITESMITHS LTD

Software: Operating Systems, Languages

97 Lowell Rd
Concord MA 01742
(617) 369-6481

WICAT SYSTEMS

Software: Budgeting/Forecasting, Word Processing/Text
Editing, Operating Systems

Hardware: Microcomputers

PO Box 535
1005 S State
Orem UT 84057
(801) 224-6400

WINTEK

Hardware: Microcomputers

1801 South St
Lakewood IN 47004
(317) 742-8428

WPL ASSOCIATES

Software: Professional Services

1100 Spring Street
Suite #2
Silver Spring MD 20910
(301) 589-6588

XCOMP

Hardware: Microcomputers

7966 Trilla St
San Diego CA 92121
(714) 271-8730

XEDEX

Hardware: Add-in/Memories

220 Rt 59
Suffern NY 10981
(914) 368-0253

XEROX

Hardware: Microcomputers

1541 W Mackinburg Ln
Dallas TX 75247
(214) 433-3441

XYCOM

Hardware: Microcomputers

750 N Maple Rd
Solana MD 48176
(313) 429-4971

XYLOGICS

Hardware: Microcomputers

144 Middleboro Turnpike
Burlington MA 01803
(617) 273-8140

**ZEDA COMPUTERS
INTERNATIONAL****Hardware:** Microcomputers

1942 W. 82nd St.

Provo, UT 84601

(801) 277-0948

ZENITH DATA SYSTEMS**Software:** Word Processing/Text Editing, Data
Communications**Hardware:** Microcomputers, Workstations, End-users,
Printers, Display Monitors

1100 Milwaukee Ave.

Oakview IL 60021

(312) 391-8101

ZENTEC**Hardware:** Microcomputers

2400 Walsh Ave.

Santa Clara CA 95050

(408) 727-7662

ZILOG**Hardware:** Microcomputers

10440 Hubb Ave.

Cupertino CA 95014

(408) 446-4666



Product Specific Vendor Directory



PRODUCT SPECIFIC VENDOR DIRECTORY

APPLICATIONS SOFTWARE

Accounts Payable

American Business Systems
ASK Micro
Burroughs
CYMA
Data Base Research
Designers & Builders of
Information Systems (DBIS)
Feith Systems & Software
Groundstar Software
Hayden Software
Info Designs
Information Unlimited Software
(IUS)
International Micro Systems (IMS)
Micro Business Software (MBSI)
Micro Data Business Forms &
Systems
Microcomputer Consultants
Midwest Computer Center
Open Systems
- Peachtree Software
Pericom Systems
Southwest Systems
State of the Art
Structured Systems Group (SSG)
Systems Plus
Taranto & Associates
TCS Software
Thoughtware Publishing
Timberline Software
Trac Line Software

Accounts Receivable

American Business Systems
ASK Micro
Bristol Information Systems
Burroughs
Compugraphic
Continental Software
CYMA
Data Base Research
Data General
Designers & Builders of
Information Systems (DBIS)

Feith Systems & Software

Groundstar Software
Hayden Software
Info Designs
Information Unlimited Software
(IUS)
International Micro Systems (IMS)
Micro Business Software (MBSI)
Micro Data Business Forms &
Systems
Microcomputer Consultants
Midwest Computer Center
MPSI (Microcol Products)
Open Systems
- Peachtree Software
Pericom Systems
Prodigy Systems
The Software Express
Software Products International
Southwest Systems
Structured Systems Group (SSG)
Systems Plus
Taranto & Associates
TCS Software
Timberline Software

General Ledger

American Business Systems
ASK Micro
Burroughs
Construction Data Control
Continental Software
CYMA
Data Base Research
Feith Systems & Software
Groundstar Software
Hayden Software
Info Designs
Information Unlimited Software
(IUS)
International Micro Systems (IMS)
Micro Business Software (MBSI)
Micro Data Business Forms &
Systems
Microcomputer Consultants
Midwest Computer Center
Occupational Computing Company
(OCC)

APPLICATIONS SOFTWARE (Cont)

Open Systems
 Peachtree Software
 Southwest Systems
 State of the Art
 Structured Systems Group (SSG)
 Systems Plus
 Taranto & Associates
 TCS Software
 Timberline Software

Payroll/Personnel

Accountants Microsystems
 American Business Systems
 ASK Micro
 Bristol Information Systems
 Burroughs
 Computer Products
 Construction Data Control
 CYMA
 Data Base Research
 Designers & Builders of
 Information Systems (DBIS)
 Feith Systems & Software
 Groundstar Software
 Hayden Software
 Higley & Co
 Info Designs
 International Micro Systems (IMS)
 Micro Business Software (MBSI)
 Micro Data Business Forms &
 Systems
 Midwest Computer Center
 Miles Computing
 Occupational Computing Company
 (OCC)
 Open Systems
 Peachtree Software
 Prodigy Systems
 Southwest Systems
 State of the Art
 Structured Systems Group (SSG)
 TCS Software
 Timberline Software

Job Costing

Argos Software
 Computer Options
 Construction Data Control
 Feith Systems & Software
 International Micro Systems (IMS)
 Micro Data Business Forms &
 Systems

Midwest Computer Center
 Open Systems
 Southwest Systems
 VialCorp

Integrated Accounting

Accountants Microsystems
 Alexander Grant & Co
 Argos Software
 ASK Micro
 BPI Systems
 Construction Data Control
 CYMA
 The Denver Software Company
 Dynamic Microprocessor
 Associates
 EF Haskell & Associates
 Great Plains Software
 Groundstar Software
 Information Unlimited Software
 (IUS)
 Insoft
 International Micro Systems (IMS)
 Jersey Micro Systems
 Micro Data Business Forms &
 Systems
 Occupational Computing Company
 (OCC)
 Pericomp Systems
 Software Products International
 Southwest Systems
 Star Software Systems
 Systems Plus
 Taranto & Associates
 Vandata
 Vector Graphic

Sales/Distribution

Acme Software
 American Business Systems
 ASK Micro
 B-Squared
 Bristol Information Systems
 Burroughs
 Compumax
 Data Base Research
 Data General
 Designers & Builders of
 Information Systems (DBIS)
 Feith Systems & Software
 General Systems Sciences
 Groundstar Software
 Hayden Software
 Info Designs

APPLICATIONS SOFTWARE (Cont)

Information Unlimited Software (IUS)
 International Market Resources
 International Micro Systems (IMS)
 MOC Software
 Micro Business Software (MBS)
 Micro Data Business Forms & Systems
 Microcomputer Consultants
 Nipenthe Programs
 Open Systems
 Peachtree Software
 Pericom Systems
 Printers Software
 Professional Business Computer Systems
 Small Business Systems Group
 SSR Corp
 State of the Art
 Structured Systems Group (SSG)
 System Integration Associates
 Systems Plus
 Taranto & Associates
 TCS Software
 Trac Line Software

Budgeting/Forecasting

Access Technology
 Addison-Wesley Publishing
 Advanced Management Strategies
 Ashton-Tate
 Automated Insurance Rating Services
 Business Planning Systems
 Business Solutions
 Chang Laboratories
 Computer Marketing Services
 Comshare
 Comshare Target Software
 Contract Management Systems
 Dakin
 Desktop Computer Software
 Digital Equipment
 Donald R. Frey & Company
 EPS
 Execucom Systems
 Ferox Microsystems
 Groundstar Software
 Harvard Software
 Hourglass Systems
 Human Systems Dynamics

Information Unlimited Software (IUS)

Instant Software
 Lifeboat Associates
 Lotus Development
 Management & Computer Services
 MCC Software
 MicroPro International
 Microsoft
 Nestar Systems
 North America MICA
 Northwest Analytical
 Olympus Software
 Osborne/McGraw Hill
 Peachtree Software
 Perfect Software
 Phase One Systems
 Pyramid Data Ltd
 Saturn Systems
 Shaffer & Shaffer Applied Research & Development
 Smoke Signal Broadcasting
 Solstar
 Softcorp International
 Softsam
 Software Arts
 Software Products International
 Software Resources
 The Software Toolworks
 Sorcim
 Special Delivery Software
 Structured Systems Group (SSG)
 Supersoft
 Systems Plus
 Tandy (Radio Shack)
 TeleVideo Systems
 Timberline Software
 Trac Line Software
 Vector Graphic
 Via Computer
 VisiCorp
 Westco
 Westminster Software
 Wicat Systems

Professional Services

Accountants Microsystems
 Allin Computer Services
 AERONICA
 AF Software Services
 AgData
 Agricultural Management Systems
 AK Rosinhan, Consulting Engineer
 Andent

APPLICATIONS SOFTWARE (Cont)

Another Direction
Appel & Kneiss Software
Applied Systems
Arbutus Totalsoft
AIRM
Bristol Information Systems
Cado Systems
Client Accounting Systems
CMA Micro Computer
CMV Software Specialists
Compasol
Computer Consulting Services
Computer Task Group
Computone Systems
Cyberia
CIMA
Dadlind
The Denver Software Company
Designers & Builders of
Information Systems (DBIS)
Digital Marketing
Eagle Software Publishing
EF Haskell & Associates
Enterprise Computer System
Fairland Computer Systems
Faith Systems & Software
H&H Scientific
Hewlett-Packard
Howard Software Services
Incom Systems
Innovative Software Associates
International Data Processing
International Micro Systems (IMS)
Jersey Micro Systems
MOC Software
McClintock
Micro Business Systems
Micro Data Business Forms &
Systems
Occupational Computing Company
(OCC)
Ohio Data Base
PK Systems
Professional Computer Services
Professional Software
Programmed Systems
R&B Computer Systems
SBCC & ELCO Systems
Senders
Single Source Solution
Software Hows

Software Products International
Software Resources
Special Delivery Software
SPECTRA/SOFT
Star Value Software
Starsoft
System Integration Associates
Systems Plus
The Systems Shoppe
Tandy (Radio Shack)
TCS Software
Technical Data
The LWF/W Group
Thoran Software (TSC)
TMS/MSC
Trac Line Software
Unique Information Systems
VistCorp
WPL Associates

Engineering/Scientific
Advanced Structural Technology
Anastol
Binkley Software
Ecom Associates
Ecosoft
Entek Scientific
Golden State Business Systems
Graphic Software Systems
Hewlett-Packard
Kelco Software Systems
Land Innovation
Lifeboat Associates
M. Hudis & Associates
MPS Company
On-Line Instrument Systems
Pacsoft
Parametrics
R&L Software
Remex
Sinclair Optics
Tandy (Radio Shack)
Ternegrity
Threshold Software
Unique Information Systems

Graphics
Accent Software
ACQUIPE
AlphaBit Communications
American Computers & Engineers
Apple Computer
AutoDesk
Autographix

APPLICATIONS SOFTWARE (Cont)

Brezza/QSD
 Business & Professional Software
 C&H Video
 Computer Stations
 Covington Computer Sales
 Cromemco
 Datagraph
 DataSoft
 Decision Resources
 Digital Research
 Epic Computer Products
 Escape Computer Software
 Ferox Microsystems
 Fox & Keller
 Geographix
 Graphic Communications
 Graphics Software
 Grid Systems
 GTCO
 Human Engineered Software
 Human Systems Dynamics
 Innovative Software
 Interactive Picture Systems
 Lotus Development
 Midwest Software
 Micro Control Systems
 Micro-Ware Distributors
 Micromotion
 MicroPro International
 Mixsys
 Morgan-Fairfield Graphics
 Multisoft
 Omicron Software
 Peachtree Software
 Precision Visuals
 Rainbow Computing
 Redding Group
 Reston Publishing
 Selanar
 Sehsa Systems
 Software Publishing
 Software Resources
 Sord Computer of America
 Stansware
 Structural Programming
 Tandy (Radio Shack)
 Vector Graphic
 VisiCorp

Word Processing/Text Editing
 AlphaBit Communications
 Applied Microcomputer Systems

Applied Technology Ventures
 ARTSCI
 Atari
 Atzin International
 Beaman Porter
 Broderbund Software
 California Digital Engineering
 Compac Systems
 Complete Computer Systems
 Computek
 Computer Development
 Computer Marketing Services
 Construction Data Control
 Comucopia Software
 Cromemco
 Distarned Research
 Datamost
 Datalek
 Designer Software
 Designers & Builders of
 Information Systems (DBIS)
 Digital Marketing
 Eivindis
 Hayden Book
 HEK Software
 Horizon Software Systems
 Human Engineered Software
 IIC
 Information Unlimited Software
 (IUS)
 International Micro Systems (IMS)
 Kensington Microware
 Lexisoft
 Lifeboat Associates
 Lifetree Software
 Logical Systems
 MA&C Software International
 Mark of the Unicorn
 MCC Software
 Metasoft
 Micro Metric
 Micromotion Ltd
 MicroPro International
 Microsoft
 MPPI (Microprobel Products)
 Muse Software
 Nordell Data Systems
 Oask Systems
 Ohio Data Base
 Ontel
 Owl Software
 Peachtree Software
 Perfect Software
 Professional Software

APPLICATIONS SOFTWARE (Cont)

Quark Engineering
RealWorld Software
Satellite Software International
Scenic Computer Systems
Select Information Services
Siema On-Line
Silicon Valley
Simulated Computer Products
SOFSYS
SoftTest
Software Dynamics
Software Libraries
Software Publishing
Software Systems
The Software Toolworks
Star Computer Group
Structured Systems Group (SSG)
Supersoft
Tandy (Radio Shack)
TronWare
Vector Graphic
Victor Business Products
J Vitkoitus Consultants
VisiCorp
Western Software Development
Wicat Systems
Zenith Data Systems

Manufacturing

Anacomp
Bernard Giffler Associates
CompuMax
Computer Methods
Digital Microsystems
Fesh Systems & Software
High Technology Software Products
Key Systems
McCullough & Associates
Micro Business Systems
Micro Manufacturing Systems
Midwest Computer Center
Olympic Systems
Professional Business Computer Systems
SBCC & ELCO Systems
Solzberg Research Associates
TCS Software
Tipnis
Trac Line Software
Viehmann

SYSTEMS SOFTWARE

Operating Systems
Apple Computer
Aton International
Cosmopolitan Electronics
Digital Research
Forth
Hunter & Ready
IBM
Intel
Lifeboat Associates
Logical Systems
Microsoft
MPSI (Microcobol Products)
Phase One Systems
Point 4 Data
SMC Software Systems
Softech Microsystems
System Integration Associates
Tandy (Radio Shack)
Western Electric
Whitesmiths Ltd
Wicat Systems

Data Base Management

AB Computers
ABW
Active Computer Enterprises
Applied Software Technology
Aston-Tate
Canton Software Publishing
CompuMax
Computer Headware
Condor Computer
Construction Data Control
Designers & Builders of Information Systems (DBIS)
ESP Computer Resources
Friends Software
GMS Systems
Groundstar Software
Holiday Software
Information Builders
Information Unlimited Software (IUS)
Innovative Software
Insoft
Jini Micro-Systems
Key Software
LJK Enterprises
Micro Applications Group
Micro Data Base Systems
MicroPro International

SYSTEMS SOFTWARE (Cont)

Molecular Computer
Multisoft
Pascal Systems
Perfect Software
Shakti Systems
The Small Computer
Software Products International
Software Publishing
Stoneware
Structured Systems Group (SSG)
Supernoft
Systems Plus
Tandy (Radio Shack)
Tarbell Electronics
TCS Software
Texas Electronic Instruments
Trac Line Software
Uveon Computer Systems
Vector Graphic

Data Communications

Abstract Systems
Ace Computer Products
Advanced Data Systems
Arrow Micro Software
Aton International
The Communi Tree Group
Computer Applications
Computer Stations
Context Management Systems
CP/M Users Group
Cyberia
Cypher Communications
Technology
Datamark Business Systems
Digital Marketing
Dow Jones
Dynamic Microprocessor
Associates
Ferox Microsystems
First Software
Hawkeye Grafik
Hayes Microcomputer Products
The Headlands Press
IBM
IE Systems
Linbergh Systems
Link Systems
Logica
Lovella
Dann McCreary Software
Micro Systems Software

Microcom
Microsoft
Monroe Systems
Mycrofit Labs
Nestar Systems
NF Systems
Philadelphia Consulting Group
Predux
Rabbit Software
Small Business Systems Group
Softtronics
Software Connections
Software Module Marketing
Software Sorcery
Southeastern Software
Southwestern Data Systems
SSM Microcomputer
Supernoft
Telephone Software Connection
Vector Graphic
VisiCorp
VM Personal Computing
Westco
Zenith Data Systems

Utilities

Acorn Software Products
Anthro-Digital
Breeze/QSD
Computer Control Systems
Competing
Datamed Research
Digital Constructs
Digital Marketing
Digital Research
Dynamic Microprocessor
Associates
EZ Software
Frontier Software
Holiday Software
Johnson Associates
Lifeboat Associates
Logical Systems
MAP Systems
Micro Applications Group
MicroPro International
Microtech Exports
Miksys
Panasonic
Relational Systems International
Small Records Associates
Software Development
Structured Systems Group (SSG)
Supernoft
Synapse Software

SYSTEMS SOFTWARE (Cont)

Tandy (Radio Shack)
Texas Instruments
VisiCorp

Program Development/Debugging

Aspen Software
Bytek
Computer Data
Computer Methods of Pennsylvania
Computer Products
Creative Solutions
Daking
Data Access
Dedicated Systems
Delphic Software Systems
Design Software
Digital Marketing
Fox & Geller
The Information People
ISI
Lifeboat Associates
Marketing Essentials
McMillan Computing Services
Micro Focus
Micosys
Quilo
Relational Systems International
The Software Group
Supersoft

Languages

Adventure International
Acor Systems
American Planning
Apple Computer
Computer Innovations
Digital Research
Einstein
Ellis Computing
Excalibur Technologies
Insolt
ISI
JRT Systems
Lifeboat Associates
MANIX Software Systems
Microsoft
Miller Microcomputer Services
MPSI (Microcobol Products)
Orntool
Oryx Systems
Ryan-McFarland
SAC Software Systems

Softech Microsystems
STSC
Supersoft
Texasoft
Whittemith Ltd

HARDWARE**Microcomputers**

Able Computer
Accelerated Data Systems
Acom Computers Ltd
Action Computer Enterprise
Alpha Micro
Allos Computer Systems
American Computers & Engineers
Apple Computer
Applied Digital Data Systems
Applied Systems
Astar
Barrington International
Basis
Billings Computer
Blackhawk Computers
BMC Computer
Burroughs
Cado Systems
Callan Data Systems
Campbell Scientific
Canon USA
Capro
Caslo
Central Data
Centurion Computer
Charles River Data Systems
Chrislin Industries
Chromatics
Cifer Systems Ltd
Colonial Data Services
Columbia Data Products
Comark
Commodore Business Machines
Compal Computer Systems
COMPAQ Computer
CompuPro
Computer Ancillaries Ltd
Computer Automation
Computer Devices
The Computerist
Computhink
Control Data
Control Logic
Corvus Systems

HARDWARE (Cont)

Cromemco
 Cybersystems
 Data General
 Data Terminal Systems
 Datamac Computer Systems
 Datamedia
 Datapoint
 Datavue
 Daticon
 Delta Data Systems
 Digicom Research
 Digilog Business Systems
 Digital Design & Development
 Digital Equipment
 Digital Laboratories
 Digital Microsystems
 Display Data
 Distributed Computer Systems
 Dual Systems
 Durango Systems
 Dynabyte
 Dynalogic Info-Tech
 Dynastem
 E&L Instruments
 E&U Engel Consulting
 Eagle Computer
 ECS Microsystems
 Epic Computer Products
 Epron America
 Eddy
 Ferranti Computer Systems Ltd
 Forethought Products
 Fortune Systems
 Franklin Computer
 Fujitsu
 Future Computers Ltd
 General Digital Industries
 Gifford Computer Systems
 Gimix
 GMR
 Grid Systems
 Grundy Business Systems Ltd
 Hewlett-Packard
 Honeywell Information Systems
 IBM
 ICL Computers
 IMS International
 Infotecs
 Instrumentation Laboratory
 Integrated Business Computers
 Intel
 Intelligent Systems

Interactive Systems Technology
 Intertec Data Systems
 Intertechnique
 The IPAC Group
 Ithaca Intersystems
 Keycomp Computers
 Keuffel & Esser
 LNW Computers
 M/A-COM Office Systems
 Mac Computer
 MAI/Basic Four
 Martec International Electronics
 Matrix Electronic Systems
 MCM Computers
 Mercator Business Systems
 Micro Five
 Micro Source
 Micro Technology Unlimited
 MicroAPL Ltd
 Microbar Systems
 Molecular Computer
 Monroe Systems
 Morrow Designs
 Motorola
 Multi-Tech Systems
 Multitech Electronics
 National Semiconductor
 NCR
 NEC Information Systems
 Nestar Systems
 NNC Electronics
 North Star Computers
 Northern Telecom
 Numeritronix
 Olivetti
 Olympia USA
 Omnibyte
 Oned
 Onyx Systems
 Osborne Computer
 OSM Computer
 Otrona
 Panasonic
 Pegasus Data Systems
 Perkin-Elmer
 Personal Micro Computers
 Pertec Computer
 PHC
 Philips Data Systems
 Plenary Systems
 Point 4 Data
 Polaris Microcomputers
 Product Associates
 Quantum Computer Systems Ltd
 Quasar Data Products

HARDWARE (Cont)

Quay
 Rair
 Rair Ltd
 Regency Systems
 RZE of America
 Sage Computer Technology
 Sanyo Business Systems
 Scentic Computer Systems
 SCI Systems
 SCI-COM Computer Systems
 Scientific Data Systems
 Scientific Micro Systems
 SCDsystems
 Seattle Computer Products
 Seesqua Computer
 Sharp Electronics
 Sierra National
 Sinclair Research
 Smoke Signal Broadcasting
 Sony
 Sord Computer of America
 STM Electronics
 Sykes Datatronics
 Tab Products
 TanData
 Tandy (Radio Shack)
 Tarbell Electronics
 Tektronix
 Teleram Communications
 TeleVideo Systems
 Terak
 Texas Instruments
 Three Rivers Computer
 Torch Computers Ltd
 Toshiba America
 Trivector Commerce Ltd
 TRW-Fujitsu
 Vector Graphic
 Victor Business Products
 Victory Computer Systems
 Wang Laboratories
 Wave Made
 Western Digital
 Wicat Systems
 Wintek
 Xerox
 Xycor
 Xylogics
 Zeda Computers International
 Zenith Data Systems
 Zentec
 Zilog

Winchesters

Ampex
 Apple Computer
 Atari
 Automated Resource Management
 BASF Systems
 Comark
 Computer System Associates
 Concus Systems
 Cynthia Peripheral
 DMA Systems
 Eagle Computer
 Epic Computer Products
 Evotek
 Hewlett-Packard
 International Memories
 Irwin Olivetti
 Memorex
 Micro Peripherals
 Microcomputer Systems
 Microtech Business Systems
 Miniscribe
 NEC Information Systems
 New World Computer
 Plessey Microsystems
 Quantum
 Rodime
 Rotating Memory Systems
 Seagate Technology
 Shugart
 SyQuest Technology
 Tallgrass Technologies
 Tandon
 Texas Instruments
 3M
 Western Dynex
 Xcomp
 Zenith Data Systems

Diskettes

Alpha Micro
 Anderson Jacobson
 Apple Computer
 BCL Technology
 Chrislin Industries
 Comark
 Commodore Business Machines
 Franklin Computer
 Hewlett-Packard
 Infotek
 Micro Peripherals
 Micro Technology
 Micro-Sci
 Micropolls
 Personal Micro Computers

HARDWARE (Cont)

Remex
Scientific Micro Systems
Shugart
Tandon
TEAC
United Peripherals
Vista Computer
Zenith Data Systems

Add-on Memories

Advanced Micro Devices
Alpha Micro
Alpha Omega Computer Systems
Andromeda Systems
Apparat
AST Research
Camdex
Central Data
Christin Industries
Chromatic
Commodore Business Machines
Computer Extension Systems
Cromemco
Datamac Computer Systems
Davong Systems
Digicomp Research
Dual Systems
Eventide
Forethought Products
G. E. Intert Systems
General Robotics
Haurikon
IDE Associates
Infotek
Ithaca Intersystems
Matrox Electronic Systems
Microsoft
Microtek
Monolithic Systems
Morrow Designs
MPC Peripherals
Omega MicroWare
PEBX
Plessey Microsystems
Plessey Peripheral Systems
Computer Products Div
Quadram
Qualitronics
Saturn Systems
Seattle Computer Products
SemiDisk Systems
Smoke Signal Broadcasting

SSM Microcomputer
Stallion Two
Systems Group
Tecmar
Telatek
Trendata/Standard Memories
Xerox

Printers

Anadex
Anderson Jacobson
Apple Computer
Azurdata
Campbell Scientific
Centronics Data Computer
Commodore Business Machines
Computer Devices
Computer Transceiver Systems
Computers International
Correx International
Data Terminals & Communications
Datapoint
Dataproducts
Datasouth
DP-Tek
Eaton Printer Products
Epson America
Fujitsu
General Electric
Heath
Hecan
Hewlett-Packard
Hi-G Printer Products
Inkscribe
Integral Data Systems
Integrex
Kaye Instruments
Mannesmann Tally
Memodyne
Microprocessor Systems
Olivetti
Olivetti
Olympia USA
Panasonic
Practical Automation
Printer Products
Qantex
Racal-Dana
Sanyo Business Systems
Sentinel Computer
Smith-Corona
Star Microdots
Tandy (Radio Shack)
Texprint
Trendcom/3M

HARDWARE (Cont)

Tymshare
Vector Graphic
Zenith Data Systems

Display Monitors
Comarc International
Dotronics
Zenith Data Systems

Modems
American Bell
Astrocom
Atari
Biscomp
Campbell Scientific
Cemtek
Codex
Coherent Communications
ComData
Commodore Business Machines
Datapoint
DataTronix
Datacube

Gandalf Data
General Datacomm Industries
GTE Lenkurt
Hayes Microcomputer Products
Hewlett-Packard
ICOT
Infotron Systems
Microperipheral
Multi-Tech Systems
NEC Information Systems
Novation
Nu Data
OmniTec Data
Prentice
Racal-Vadic
Ricon
Tek-Com
Timesplex
TNW
Tri-Data
Tuck Electronics
U.S. Robotics
Universal Data Systems
Ven-Tel
Visionary Electronics

Microcomputer Reports

GLOSSARY OF ABBREVIATIONS AND TERMS

AC alternating current

ACC asynchronous communications controller

access time 1. the interval between the initial request for information from the system and its final output 2. the interval between the initial request to store information and actual storage

addl additional

address the location where information is stored—usually assigned a label, name, or number

ALGOL algorithmic language

ALU arithmetic logic unit

A/N alphanumeric

ANS American National Standard

ANSI American National Standards Institute

APL a programming language

arith arithmetic

ASCII American Standard Code for Information Interchange

ASR automatic send/receive

Assembler computer program that produces machine instructions from symbolic input data

async asynchronous; a mode of communications that provides a variable time interval between characters during a transmission

aux auxiliary

avail. available

avg average

B byte; a segment of adjacent binary digits, usually shorter than a word

b bit—binary digit; the smallest unit of information used in a computer

BASIC Beginners' All-Purpose Symbolic Instruction Code

BCD binary-coded decimal

bisync bisynchronous; data transmission in which the synchronization of characters is controlled by timing signals at the sending and receiving stations

bit map a type of display screen that features an image generated by the bit map memory; the bit map has a bit for every point on the screen and usually produces a very high resolution

BMMC basic monthly maintenance charge
bootstrap a machine routine in which the initial instructions are sufficient to bring the remainder of the routine into the computer from an input device
bpi bits per inch
bps bits per second
BSC binary synchronous (bimynchronous) communications
bubble memory a nonvolatile memory system that uses bubblelike magnetic fields to store and retrieve data. This type of memory is faster than magnetic tape or hard disk devices and can be used in harsh environments
buffer an area of storage temporarily reserved for use in performing input/output operations into which data can be read, or from which data is written
bus a data channel (usually between a computer and peripheral equipment) over which electrical signals and data are transmitted

CAD computer-aided design
CAE computer-aided engineering
CAI computer-aided instruction
CAM computer-aided manufacturing
CCITT Consultative Committee for International Telephony & Telegraphy
chan channel
char. character; a letter, digit, or other symbol that can be represented in computer language by a unique binary code
CMOS complementary metal oxide semiconductor
COBOL Common Business-Oriented Language
CODASYL Conference on Data System Languages
col column
config configuration
control. controller; directs the transmission of data over the data links of a network or peripheral device
cpi characters per inch
ctl characters per line
CP/M Control Program for Microcomputers (Digital Research)
cps characters per second
CPU central processing unit
CRT cathode-ray tube
cursor an indicator used in CRT terminals that points out the character to be corrected or the position where data is to be entered
cycle time the time needed to write or read into a computer system's memory
cyl cylinder

DASD direct access storage device
dbl double
DBMS data base management system

DC direct current
DOP distributed data processing
debug to check the logic of a program to isolate and remove mistakes from a computer program
diag diagonal
direct addressing a method of accessing a register so that the contents are immediately acted upon
DMA direct memory access; permits input/output transfers directly into or out of memory without going through the processor's general registers
doc document
DOS disk operating system
DP data processing
dpm documents per minute
DRAM dynamic random-access memory

ea each
EBCDIC extended binary-coded decimal interchange code
ECC error checking and correcting
EDP electronic data processing
EIA Electronics Industry Association
EPROM erasable programmable read-only memory
equip. equipment
excl excluding

FDX full duplex
file management the recording, duplication, distribution, storage, retrieval, display, and hard copying of documents
font a character set using a particular style and size of type
FORTRAN formula translator

G 1. giga (billion) 2. 1,073,741,800 units
GB gigabyte (billion bytes)
gp general-purpose

HASP Houston Automatic Spooling Processor
hd head
HDLC high-level data link control
HDX half duplex
horiz horizontal
HP-IB Hewlett-Packard Interface Bus
hr hour
Hz hertz

IC integrated circuit
in. inch

Incl include

Interface the connection or point of connection of separate devices or systems

Interpreter a program that translates and executes a source language statement before it performs the same operations on the next one

Interrupt a break in the normal flow of a computer routine that allows the computer to sense special conditions without scanning the entire system

I/O input/output

IOP input/output processor

ips inches per second

ISAM indexed sequential access method

JCL job control language

K 1. kilo (thousand) 2. 1,024 units

KB kilobyte (thousand bytes)

kHz kilohertz (thousand hertz)

KSR keyboard send/receive set

kybd keyboard

LAN local area network; links computer systems, terminals, storage devices, and programs over relatively small geographic areas for rapid communication

LCD liquid-crystal display

LED light-emitting diode

lpi lines per inch

lpm lines per minute

LSI large-scale integration

M 1. mega (million) 2. 1,048,576 units

mA milliamperes

mag magnetic

max maximum

MB megabyte (million bytes)

MHz megahertz (million hertz)

min minimum

MIS management information system

mo month

modem a device used to modulate and demodulate signals transmitted over various communications facilities

MOS metal oxide semiconductor

mouse a device used to control the position of the cursor on a display screen; as this handheld device is moved along the top of a desk, it moves the position of the cursor on the display

MRJE multiple remote job entry
msec millisecond (thousandth of a second)
MSI medium-scale integration
MTBF mean time between failures
mux multiplexor

NA not applicable
NMOS negative channel metal oxide semiconductor
nonvolatile memory a type of memory that continues to hold data even when power has been disconnected
NRZ nonreturn to zero
NRZI nonreturn to zero Inverted
nanosec nanosecond (billionth of a second)

OEM original equipment manufacturer
oper operation, operator
opt. optional
OS operating system

PC printed circuit
PE phase encoded
pixel picture element
PMOS positive channel metal oxide semiconductor
prgmb1 programmable
proc processor
PROM programmable read-only memory
protocol a code involving characters and symbols without syntax; it is not a language, but it is used for communications by a computer system
pt point

QSAM queued sequential access method
QWERTY the standard typewriter keyboard arrangement

RAM random-access memory
rd read
REPROM reprogrammable read-only memory
req require
RJE remote job entry
RO receive only
ROM read-only memory
RPG report program generator language
rpm revolutions per minute

SAM sequential access method
SDLC synchronous data link control

as second
serial interface transmission of data bit by bit rather than in bytes
SMD storage module drive
SNA systems network architecture
SOS silicon on sapphire
spec specification
SSI small-scale integration
stack an area in memory where data is stored temporarily
std standard
sync synchronous; a mode of communications in which transmission is timed by a signal generated by a clock
SYSGEN systems generation

term, terminal
trk track
TTL transistor-to-transistor logic
TTY teletypewriter
TWX teletypewriter exchange service

UDLC Univac Data Link Control
unavail unavailable

v volts
VDT video display terminal
VDU video display unit
vert vertical
VLSI very large scale integration
VMOS v-channel metal oxide semiconductor
volatile memory a type of memory that permanently loses all stored information when the power has been removed
VS virtual storage

w/ with
WATS wide area telecommunications service
WCS writable control storage
w/ word
w/o without
worksta workstation
WP word processing

Xfer transfer

yr year

Special Characters

- μ programmed microprogrammed
- μ sec microsecond (millionth of a second)
- information unavailable at press time
- % percent
- / per

CONSIDERATIONS FOR DEVELOPING MICROCOMPUTER NETWORKS FOR MANUFACTURING APPLICATIONS

by: Jim B. Young
A.G. Smith
Brown Deer WI

EVALUATING MICROCOMPUTERS AND COMPUTER NETWORKS

Microcomputers offer low-cost and efficient computing resources for manufacturing control systems. In some companies, they can replace mainframes and perform functions for which automation could not otherwise be justified. In large companies, microcomputers can be used along with minicomputers and mainframes, providing functional flexibility and accessibility as well as relieving the larger machines of substantial work. Even in very large companies, microcomputers can be applied as standalone processors and as elements in computer networks of all sizes.

This article is intended to support manufacturing managers in evaluating microcomputers and networked computer systems in relation to their companies' information needs. It discusses microcomputer applications in manufacturing and surveys the advantages and disadvantages of microcomputers as standalone and as networked systems. Recognizing the trend toward networked systems, this article discusses network communications; it is supported with an appendix that focuses on the technical issues and terminology that managers should be aware of when planning a networked system.

Advantages of Microcomputers

In relation to mainframes—and even minicomputers—microcomputers offer significant advantages in terms of response time, dedicated use, software availability, reliability, and cost.

Response Time. Microcomputer response time can be faster than that of minicomputers or mainframes because the microcomputer is dedicated to a single user's data processing tasks. In larger systems,

work may be processed by a communications controller, passed to the main computer through a telephone line, wait queued for processing, and then be passed back to the user through the network. Although the microcomputer's actual computing time is significantly longer than that of the larger machines, given selected applications, little computing usually is required to serve most requests. When requests do not involve complex retrievals and calculations (the forte of mainframe computing), microcomputer response times can be shorter than those of a mainframe.

Dedicated Use. To the extent that microcomputers are under the user's control, they can free the user from the delays sometimes associated with receiving computing services from a central DP organization. When trained in basic microcomputing operation, users can often solve business problems with standard hardware and software packages in less time and at lower cost than can be achieved by a central DP group. In some cases, dedicated microcomputers can enhance security by limiting data security responsibility to one person and by giving that person sole access to the program and data diskettes.

Software. Microcomputers enjoy the advantage of recently designed software—that is, software that tends to be easier to use and more flexible than minicomputer and mainframe software. These advantages are due in part to concurrent developments in hardware and software technology, the relative simplicity of programming for microcomputers, and the highly competitive market in which software is usually sold directly to the users.

Reliability. Microcomputer reliability is generally much better than that of minicomputers and mainframes, which are significantly more complex and, if older, use less advanced and less reliable technology. Although service is better for the larger machines, the actual result often favors the microcomputer.

Cost. Microcomputers enjoy a cost advantage. A fully equipped and staffed mainframe costs millions of dollars—substantially more than a fully equipped and staffed microcomputer. (A microcomputer with good memory and storage capacity and an assortment of business software can be purchased for less than \$12,000.)

Disadvantages of Microcomputers

Although microcomputers are inexpensive and relatively reliable, they have disadvantages that must be considered. Slow response time for certain kinds of applications and lack of vendor support are the major drawbacks.

Size and Speed. From a user's perspective, the computer's speed is related to the time required for data to move through the network to and from the computer, the time data spends queued for the pro-

cessor, actual computing time, and the time spent waiting for data to be transferred to and from storage units. Microcomputers have no network and waiting time but compute at rates from 10 to 1,000 times slower than those of mainframes. Therefore, applications involving many mathematical calculations are probably better performed by larger computers.

Microcomputer data transfer rates are slow and the disk drives have limited storage capacity. One large Winchester disk drive sold for microcomputer applications holds approximately 40 million characters, compared to the more than 300 million of one vendor's mainframe. The mainframe is capable of addressing dozens of disk drives, whereas the microcomputer is generally limited to three or four.

In many manufacturing systems applications, the data is too great to pass through a single keyboard. Because microcomputers support only one user at a time, they may be adequate for manufacturing systems in only very small companies. Although some commercially available microcomputer operating systems allow more than one simultaneous user and more than one keyboard, they may not solve the speed problem, because overall system capacity is still limited by processor speed and software efficiency. If large volumes of data must be accessed in a short time, microcomputers are unusable. Similarly, complex applications such as regenerative material requirements planning (mrp) and product costing are faster on mainframes.

Vendor Support. An important microcomputer advantage is also a major disadvantage: independence from other users and the central DP facility also means that support responsibility falls on the user. Microcomputer hardware and software vendors depend on volume for profit. Some microcomputer hardware is supported through a carry-in repair service, any hardware problem is likely to put a microcomputer out of service for at least a day and possibly for weeks. Sometimes hardware support involves mail-in service, requiring between two and ten weeks. Service contracts for in-plant service are available, but, if parts are unavailable, in-plant service may be no faster than carry-in service. Service quality varies because many service technicians work on many vendors' products. Offsetting the support disadvantage is the fact that microcomputers are simpler than larger ones and tend to need less service.

Software support usually is offered in the form of a hot-line phone number. If the hot line is restricted to dealers, the user must persuade the dealer that the software publisher should be contacted. Some vendors offer no software support.

MANUFACTURING APPLICATIONS OF MICROCOMPUTERS

As previously discussed, microcomputers are inappropriate for applications that require complex mathematical calculations or high volumes of data. Because they can provide relatively low-cost and

fast computing, they are appropriate for the following manufacturing applications:

- **Financial systems**—For microcomputers, software packages include accounts receivable and payable, general ledger, and payroll. (These microcomputer applications are especially beneficial in small companies automating financial functions for the first time.)
- **Word processing**—Many companies have found that microcomputers can contribute significantly to office efficiency by eliminating much manual effort.
- **Spreadsheet programs**—Financial modeling programs (such as VisiCalc and SuperCalc) developed for microcomputers are powerful tools for projecting financial statements, planning cash flow and production requirements, and performing analyses involving data in time-series form. In addition, available software can convert spreadsheet data into graphic form.
- **Inventory control**—In small companies and organizations within large companies, the benefits of automating inventory control generally justify the purchase price of the hardware and software. Microcomputer-based inventory control is especially successful when one person is accountable for inventory control. Most available software assumes that all transactions are reported through a single keyboard, and users should not have to vie for access to it.
- **mrp**—Some companies are running mrp systems on microcomputers, and industry observers expect software costs to drop soon below \$10,000, bringing mrp within the reach of even small companies.
- **Order entry**—Some financial systems include order entry, shipping, and billing functions; the computer generates order and shipping documents, invoices, and a variety of reports and graphs based on sales history. It automatically calculates prices and discounts and sales functions. Some systems are also interfaced to accounting systems.
- **Direct data entry**—Inventory control systems that use data input devices other than the microcomputer keyboard are available. For example, interface hardware for bar-code readers is on the market, although on a limited basis. Improved disk data storage technology is expected to reduce access times and increase file storage capacities.
- **Bills of material**—Bill of material systems available for microcomputers are being enhanced to provide more features and functions. Improved systems are likely to be much faster and to support at least one form of engineering change control.
- **Purchasing and receiving functions**—Microcomputers are well suited to purchasing and receiving applications because response time and reliability are more important than computing capacity. Purchase order preparation requires the close control of the buyer; a dedicated computer can access the limited data concerning vendors and ordered items. The receiving function in-

volves an interface with purchasing and little computing. The receiving system simply captures new order information from purchasing, stores it until the material is received, and transmits it to the stockroom and to accounts payable or diverts it to quality control or to the buyer.

- **Shop floor control**—Software for microcomputers includes shop order creation and work-in-process tracking by order and by work center.
- **Quality control analysis and labor productivity measurement** can use currently available statistical analysis systems. If the microcomputer-based receiving and shop floor systems can collect information about scrap and rejects, the basic data required for quality control analysis is available. If the shop floor control system can collect clock card and job ticket information, and if the bill of material system contains standard times, labor productivity measurement can be performed by a report-writing program.

Benefits of Networked Systems for Manufacturing Applications

Microcomputers can be implemented as standalone systems or networked in such a way that each user has the benefits of a dedicated computer and can share information with other network users. A computer network consists essentially of three or more computers that can communicate with each other. The network configuration can include mainframes and minicomputers as well as microcomputers. In addition, it can include a wide variety of special-purpose devices (e.g., printers, disk drives, machine sensors) appropriate for the specific applications. The network can link users in a limited geographical area (i.e., a local area network) or in different cities (i.e., a public network).

Microcomputer system networks for manufacturing applications can provide many benefits. Few of these, however, can easily be quantified. Among the intangible but significant benefits of microcomputer networks are the following:

- They coordinate the operation of remote plants, warehouses, and offices. For instance, materials can be transferred between plants in several cities according to a common manufacturing plan. Communications over the network help to ensure that a fabrication plant makes the parts needed by the assembly plant to meet its schedules. The network can also link distribution warehouses and the purchasing department to the assembly plant.
- They communicate and coordinate plan changes quickly. An assembly schedule change that alters component parts requirements must be reflected immediately in the fabrication plant's schedule to prevent production of unnecessary stock and minimize the likelihood of shortages.
- They foster formal system success by promoting a sense of responsibility among users. Many manufacturing systems fail be-

cause users neglect to maintain accurate data. If one person is responsible for maintaining the on-hand balance information for a group of parts and has the necessary computer-based tools at hand, the reliability of the data should dramatically improve. One reason is that the person becomes accountable for accuracy, and the modular microcomputer software can be very responsive to the user's information needs. Furthermore, the person who is given this control over the data will develop a sense of personal pride in the accuracy and timeliness of the data.

- They contribute to the productivity of manufacturing managers. Electronic mail and word processing features as well as easy access to internal and external data sources and spreadsheet analysis programs can be of significant value.

ALTERNATIVE MICROCOMPUTER SYSTEM CONFIGURATIONS

Most manufacturing system applications operating on microcomputers are single-machine systems in which one microcomputer performs all the required functions at different times. The user can run any function but only one at a time. Because system modules are reasonably well integrated and all files can be updated immediately, duplicate data entry for separate modules or programs is infrequently required.

The single-machine system is adequate for very small manufacturing companies because the daily volume of data can be handled with one keyboard, one CRT, and one printer in one working day. In larger companies, however, the single-machine manufacturing system is inadequate because there are not enough hours in the day for everyone to use it. One way around the keyboard bottleneck is to purchase several microcomputers and additional copies of the manufacturing system software. Most available software cannot coordinate the operation of several computers using copies of the same software. Each user has to maintain a separate copy of required data. The effort required for multiple entry of data into several microcomputers and for verifying that all copies are identical negates the advantages of duplicating the software.

Vendors of microcomputer manufacturing systems recognize the keyboard bottleneck and are designing a second generation of software primarily aimed at relieving it. Three methods are being considered: multiprogramming/multi-user systems, centrally controlled networks, and distributed networks. Each has its advantages and disadvantages; the trade-offs are discussed in the following sections.

Multiprogramming/Multi-user Systems

The least complex solution to the keyboard bottleneck problem is the addition of keyboards. Currently available operating system software mimics multiprogramming minicomputer and mainframe operating systems and permits a single microcomputer to operate several

programs simultaneously. Several "dumb" terminals can be connected to a microcomputer, and each can independently support a user with a keyboard. In comparison to multiple microcomputers, multiprogramming/multi-user operating systems represent an improvement in communications between users. Because all users are linked to one computer, they can share a single data base and the major communications problems associated with separate computers are resolved.

Although multiprogramming/multi-user operating systems can resolve the keyboard bottleneck to some extent, they raise questions about the ability of a single microcomputer to handle many users simultaneously without losing a significant portion of the response-time advantage. These systems limit growth potential to the capabilities of a single processor. Furthermore, only one user at a time has access to the system controls and disk drives.

Centrally Controlled Networks

Some commercial networked systems permit a number of microcomputers to share common data on a central disk drive. The disk drive controller can accept simultaneous input from several microcomputers and acts as a central network controller. All requests for data from the disk, all data to be stored on the disk, and all messages between microcomputers pass through the central controller, which does the "bookkeeping" required to make the network run smoothly.

A major benefit of a centrally controlled network is the division of tasks among several intelligent computers. The controller relieves the microcomputers of most of the work associated with networking, and they relieve the controller of work on application programs. Theoretically, networked systems can support a very large number of workstations. When a single network controller is loaded to capacity, additional ones can be added to support more workstations.

Distributed Control Networks

The third microcomputer system configuration eliminates the central data base, distributes data among the users according to maintenance responsibilities, and uses software that permits users to communicate directly through the network; each system module is responsible for a share of the control duties.

Eliminating the central network controller and the central data base has advantages. First, distributed networking permits users to control the data. In contrast, a central data base spreads this control among users and hinders data accuracy measurement on an individual basis. A second advantage is that distributed networking systems separate individual workstations and give the system designers freedom to match hardware capabilities to tasks to a greater degree than do centrally controlled systems—that is, distributed manufacturing systems can include all sizes of hardware, various installation locations, and several organizations.

For example, a company can operate a broad range of hardware, all using a single, integrated software system. The company's major applications (e.g., mrp and product costing) can be run on a high-speed mainframe computer. Buyers, schedulers, and planners can work independently and access the network through dedicated microcomputers. Users enjoy the combined advantages of a dedicated computer, the high-speed mainframe computing, and access to data entered and verified by others.

Distributed networking systems are more expensive to program than simpler network configurations because a much wider range of hardware must be accommodated. Support costs are also higher because knowledge of different hardware and software is required to maintain the system. Although distributed networking systems are infrequently used, they are expected to be more common by the end of this decade.

Centralized versus Decentralized Network Control

Network control is centralized when only one of the devices attached to the network is able to route messages. In a centralized network, all messages from all remote devices are transmitted to the one device that can perform routing. That device interprets the messages and reroutes them to their destinations. In a completely distributed network, every device would be capable of routing messages directly to every other device. Centralized networks are generally cheaper to create than distributed ones because only one device needs to be programmed for message routing and only one program needs to be changed when the network changes. Because every message has to be transmitted twice (once to the controller and once to the destination), however, the overall network capacity is reduced.

Most large networks are a hybrid of centralized and distributed control. Some devices are able to route messages directly, some are able to route part of their traffic directly, and some must rely entirely on central controllers.

NETWORK COMMUNICATIONS

When two people talk on the telephone, they are exchanging messages. One person talks for a time, then the other. Sometimes both begin talking at the same time and pause, and then one person takes control of the conversation and proceeds. Computer communication works in a similar fashion. However, it is usually shorter and contains little redundant information, maximizing the rate of information flow. Error-detection schemes built into the messages permit frequent error checking.

For instance, if one computer is to inform another that a new item has been added to the master file and that the receiving computer should update its files, the sending computer transmits several pieces of information. The transmission probably includes a code indicating that the message concerns a new record on the item master,

the new item's part number, its description, and other specific information. Because the transaction can involve more than 100 characters, it may be broken into several messages, each related to the other by additional codes and protected during the transmission by error-detection codes. The receiving computer receives the first message, learns that a new item master record is involved, and awaits the remaining parts of the transaction. At the end of each message (or in some systems, the entire transaction), the receiving computer sends an acknowledgment back to the sending computer. If errors are detected, the receiving computer returns a negative acknowledgment and the sending computer repeats the data until a positive acknowledgment is received.

Communications Protocols

The rules governing the interaction of network devices are called protocols, and specifications range from voltages to message formats.

The following list briefly describes types of communications protocols, and they are discussed in depth in the appendix of this article.

1. Physical protocols cover specifications for transmission media, including electrical wire, microwave, fiber optics, and audible sound.
2. Link protocols govern the logic used to transmit messages, including synchronous, asynchronous, and binary synchronous communications.
3. Network and transport protocols determine how messages are routed to devices in the network.
4. Session and presentation protocols are used to specify connection and disconnection procedures and to restrict transmission time.
5. Application protocols specify the formats with which the networked computers communicate application-specific information.

Although vendors are attempting to develop standardized protocols, none is likely to emerge as preeminent. Greater standardization should reduce the number of design decisions that must be made. A higher degree of standardization can also be expected to benefit users by offering a variety of successful solutions to communications problems as well as lower system costs.

Reducing Network Communications Costs

In the absence of standardized protocols, network communications costs can be reduced by good design. For example, designs that minimize telephone bills, the length of communications lines, and the number of lines can achieve significant savings.

Public Facilities. Local area networks are usually restricted to small geographic areas and can use private communications lines.

For large, geographically spread networks, however, the cost of private communications lines is usually prohibitive, and public lines are used. Lines leased and conditioned by the phone company can achieve transmission speeds fast enough to drive a 600-line-per-minute printer, which is adequate for most manufacturing purposes. The cost of long-distance computer communications is usually related to the services provided by the telephone company. To minimize telephone bills, potential users can consider arrangements with telephone companies that sell time on private telephone lines at reduced cost.

Line Connection Schemes. Another source of savings is the physical design of the network. For example, a network connecting Boston with New York, Philadelphia, Cleveland, and Chicago could use lines from each city to all other cities, a total length of about 5,000 miles. If, however, the same network connected only Chicago with Cleveland, Cleveland with New York, and New York with both Philadelphia and Boston, it might accomplish the same objectives with only 1,100 miles of line. Although the computers in Cleveland and New York might have to be larger to handle the additional traffic, the total system cost could be substantially reduced. Thus, the physical design of large networks is a complex task requiring a good knowledge of the applicable tariffs, networking technology, and the traffic passing over the network.

Multiple Transmissions. Multiplexors, devices that allow more than one network conversation at a time on a single line, can extend the use of single telephone lines. A frequency multiplexor transmits several different electrical frequencies at one time, superimposing different computer conversations on different frequencies. Few computers make full use of the available time on the line; time-division and statistical multiplexors coordinate traffic, permit different conversations to occur at different times, and operate fast enough to make delays nearly unnoticeable by the user. Time-division multiplexors parcel out time in predetermined pieces, whereas statistical multiplexors parcel it out according to the need of each device. Statistical multiplexors make better use of the line than time-division multiplexors, but they cost more. Multiplexors can substantially increase the effective capacity of a communications line. Their cost is easily justified when the line is long and costly, used by many devices, and inadequate for heavy traffic.

FINAL CONSIDERATIONS

Managers of companies considering or planning a microcomputer network should recognize that the technology is still developing. They should proceed with caution and evaluate the following issues:

- **Technical complexity**—Although improved standards are reducing the complexity of network design, designing an effective and efficient network requires experience and expertise. In addition

to the cost of design experts, companies can expect substantial continuing costs of personnel to support the network.

- **Technical development**—As discussed in this article, standard protocols have evolved through the physical and link levels of communication, and the work continues. Recent announcements of standard networking schemes by several major computer vendors promise significant benefits for new installations. If standards are different from those adopted for existing networks, costs for expansion, change, and additional maintenance may be incurred.
- **Expanded capacity**—Like all computer systems, successful networks usually grow. As users discover the network's capabilities, they use it more. Managers must be certain to avoid having planned network designs fit the estimated traffic volumes so closely that they require major expenditures to add new devices when increased capacity is needed.

APPENDIX

Considerations for Planning Computer Network Communications

This appendix is intended to support the project manager responsible for computer network project planning. It offers a discussion of communications protocols, defines some of the basic terminology, and describes the current state of standardization.

Physical Protocols

Communications between computers can be transmitted through various media, including electrical wire, microwave, fiber optics, and audible sound transmission. Since the same principles apply to all media, for simplicity this discussion considers only transmission through a wire.

Digital and Analog Transmission. One of the first design decisions for a physical communications protocol is determining whether the transmissions must be digital or analog. If telephone lines are used, communications must be in an analog mode because the phone system is designed primarily for analog transmission. (Although Bell Telephone Company provides digital data service among some cities, most computer communication is analog.) For analog transmissions, a modem is required to convert the computer's digital signal to an analog one, and a second modem is required at the receiving end to convert it back.

Because Bell Telephone was among the first to produce and use modems, the Bell physical protocols have become relatively standard throughout the communications industry. Bell's standards specify physical characteristics such as voltage levels, the rate of bit transmission, and other basic properties. Most other modem manufacturers make units that are advertised as Bell compatible.

Digital transmission requires no modems and can be used in most plants. If all the devices in the network have the same voltage levels and speeds, they can be directly wired together; otherwise, equipment to compensate for the differences is needed. One good approach to coordinating mismatched devices uses a pair of modems to perform analog and digital conversions.

Several commonly accepted standards have been developed for digital input and output from the devices on a network. One, for instance, specifies that the bits making up a transmission should move in serial form (i.e., one after the other) down a single wire and defines voltage levels and other physical characteristics. In parallel transmission, bits making up a single character travel in parallel, each bit on its own wire. Although parallel transmission can be faster than serial, it is more sensitive to electrical interference and is useful over only very short distances.

Bandwidth Considerations. Multiple signals can be transmitted over a single circuit if each signal is transmitted on its own frequency. The term *bandwidth* refers to the range of frequencies used on a line, the number of simultaneous transmissions possible, and, therefore, the data capacity of the line. Broadband lines can handle much more data than baseband ones but also require relatively expensive conversion equipment for each device in the network.

Broadband signaling is most economical when the volume of data transmission is high, distances are great (involving high costs per circuit), and the devices on the network are permanently attached. Transmissions within a manufacturing plant are likely to use baseband signaling because distances are relatively short, wiring costs relatively low, transmission volumes light, and the number of devices high.

Link Protocols

Link protocols are the logical methods used to pass messages. The two types are synchronous (sync) communication, which uses an internal clock to synchronize transmissions in time, and asynchronous (async) communication, which allows all devices to transmit at will. Asynchronous communication is usually one character at a time (i.e., the message length is a single character), whereas synchronous communication consists of variable-length messages. Because error-detection and confirmation transmissions are included in both types of transmission, asynchronous is substantially slower than synchronous communication; the equipment required for asynchronous transmission is, however, simpler and less expensive.

Asynchronous communication is usually best suited to environments in which devices transmit and receive only sporadically; synchronous communication is best suited for continuous transmission at high speeds. A shop floor data collection system, for example, can communicate with its data collection terminals via asynchronous

lines. Communication with the host computer can use a bisynchronous (binary synchronous) line, a type of synchronous communication designed for high-volume, direct computer-to-computer applications.

Communications protocols can permit only one device to transmit at a time (half-duplex communication) or both devices to transmit simultaneously over separate wires (full-duplex communication). Bisync communication is always half-duplex.

ASCII and EBCDIC. The two methods of representing the characters understood by humans in the binary code used by computers are ASCII and EBCDIC. Any network can carry either ASCII or EBCDIC messages, but the devices on the line can understand only one of the two. (Most vendors use ASCII; all IBM equipment, however, is EBCDIC. To be plug compatible with IBM, equipment must be EBCDIC.) Conversion equipment can be used to permit ASCII and EBCDIC machines to communicate, but converters are an additional network expense.

Error detection is also part of most link protocols. On most networks, electrical interference frequently results in transmission errors. Since error detection and correction are cheaper than the heavy shielding required to prevent errors, essentially all computer communications involve some detection and correction scheme. Most of the numerous error-detection methods can detect between 80 and 90 percent of the transmission errors. Combining several methods raises overall reliability to acceptable levels. Most error detection and correction are performed by purchased hardware.

Network and Transport Protocols

Networks can be relatively simple (e.g., a shop floor data collection network in which several terminals feed information into a single computer) or very complex (e.g., state-wide electronic funds-transfer systems in which hundreds of devices, including many different kinds of terminals and mainframe computers, are linked).

Routing. Some networks broadcast all messages to all points and depend on each device to identify and act on only those messages intended for it. Other networks relay messages through regional processors with each regional processor identifying the ultimate destinations of the messages and deciding how to route them. Practical and effective routing schemes are of crucial importance in designing an efficient relaying network.

Message Packets. Networks sometimes divide messages into standard-size packets and route them through the networks for reassembly into the complete messages at the destinations. These packets increase network efficiency because the packet length is fixed and the need to annotate each message with its length is eliminated. An

efficient method is needed for subdividing messages and reassembling them in the correct sequence at the destination.

Token-Passing Techniques. Networks that permit only one device to transmit at a time sometimes use token-passing techniques. First, a transmission sequence is defined. As each device completes its transmission, it sends a signal to the next device in the sequence, giving it the go-ahead to transmit. Although token passing is a simple and easily understood way of preventing transmission collisions, the time it requires diminishes network capacity.

Session and Presentation Protocols

Session protocols include the methods and techniques used to connect and disconnect network devices. Even permanently connected networks usually require connection and disconnection logic to allow for device installations and removals. Some networks, such as central time-sharing systems, use multilevel connection and disconnection routines in which users must sign on to the network and separately sign on to the time-sharing service. Session protocols also include logic to reconnect after a line failure.

Security Codes. Networks that involve security codes require security logic at the session (and possibly at the presentation) level of their protocols. (Network security is a complex topic beyond the scope of this article.) Security protocols can include passwords for sessions, applications, programs, and/or data. Encryption and decryption of data may be useful.

Transmission-Time Restrictions. Some networks specify a maximum transmission time. Baseband networks, which permit only one user at a time to transmit, can assure all users of a minimal level of access to the network by restricting each device to a preestablished length of transmission time.

Data Compression. Data compression techniques reduce transmission time without sacrificing information content and effectively increase network capacity with no increase in cost. For example, if a manufacturer's part number always contains a dash in positions 4 and 9, the network can specify that these characters be deleted by the transmitting device and reinserted by the receiving device. Word processing networks can benefit from brief codes used in place of common phrases.

Application Protocols

The highest level in a communications protocol involves the programs themselves. How, for instance, does the shop floor minicomputer communicate the completion of an order to the computer that controls the finished stock and shipments? The minicomputer's message usually contains the following:

- The finished stock computer's address, which is by the network for routing and by the finished stock computer for message identification.
- A code (sometimes called a transaction code) that identifies the meaning and content of the message. For instance, code "ABC" might identify the shipment of an order from the shop floor to the finished goods stockroom. When the finished stock computer receives a code ABC message, it knows that the seven characters immediately following the code represent the order number, that the next 12 represent the part number.
- The data itself, which in this case includes the part number, quantity completed, and other information such as the completing department, the inspector's name, and the order number.

When the shop floor computer enters its message into the network, several things can happen, depending on the design of the network. In one scheme, the network controller attached to the shop floor computer reads the destination code and determines the transmission line. It can add error-checking characters to the message and then send it to its modem over a short connecting cable. The modem converts the message from digital to analog and adds error-checking information.

The message then travels over the network, possibly passing through telephone company repeaters and over microwave and/or satellite links until it arrives at the end of the line and is received by the finished stock computer's modem. This modem converts the message back to digital form, verifies that the message is correct according to its error-checking routines, and passes it to the stock computer's network controller. The network controller performs additional error checking, and passes the message directly into the I/O port of the finished stock computer.

HARDWARE ACCEPTANCE TESTING FOR SMALL COMPUTERS

by: Paul J. Jellie and James D. Schoeffler
Cleveland State University
Cleveland, OH

PROBLEMS ADDRESSED

Unlike large computer systems, small computers are sold through distribution channels ranging from software houses to computer stores. These computer systems are often assembled with components from various hardware and software vendors, which sometimes results in a system that is unacceptable for the user's application. Consequently, careful consideration of the computer system's intended use and of its specification and acceptance testing is necessary.

Unfortunately, however, written detailed specifications accompanied by a request to bid are uncommon unless the user is buying in large quantity. Small computer systems have relatively low prices and corresponding profit margins that preclude a local computer store, for example, from preparing detailed written bids in response to such specifications.

The solution to this problem is twofold: The hardware and software features important to the user's applications must be identified. Key hardware features are outlined in this article. Those hardware and software features most important and critical to the applications intended for the machine should be evaluated before purchase. Typically, this is easily accomplished, because small computers are generally available for observation, testing, and benchmarking. Furthermore, most applications software consists of generic application packages that can be demonstrated and benchmarked. Acceptance testing of the most critical functions thus can be performed before selecting a particular hardware and software system, leaving very little to be performed after system delivery. This article discusses the critical characteristics of each hardware system component and its related acceptance testing.

GENERAL SPECIFICATION AND ACCEPTANCE TESTING

Five general categories of hardware specification and acceptance testing are important to a small computer system.

Software Compatibility

The hardware specified should be compatible with the selected

combination of application software and software operating system should be specified.

Potential for Expansion

A hardware system whose capacity and capability for future expansion is compatible with selected application software should be specified. Capacity limits that must be determined and checked include the following.

Speed. Whether the processor is sufficiently fast to execute the selected application programs in a reasonable time should be determined. This speed requirement cannot be posed in terms of raw computer speed; instead, it must be evaluated relative to the actual application software packages to be used. A limitation caused by speed manifests itself in several ways:

- An application involving excessive computation may simply take too long to be useful (e.g., certain complex spreadsheet planning applications).
- An application may require frequent access to data recorded on diskettes whose access time may be too slow to permit effective use of the application.
- An application requiring transmission of data to or from another computer may be unacceptable because of a limit on the rate at which data can be transmitted.
- If the system has multiple users, the evaluation should include the effects of concurrent use by the contemplated number of users.

Internal Storage Capacity. It is important to determine whether the capacity of internal storage is sufficient to support the selected operating system and applications software. Again, this requirement is tied to the particular application packages to be used with the system.

In addition, internal storage expansion capability must be sufficient for anticipated future applications. Many small (8-bit) computers cannot be expanded beyond 64K bytes of primary storage. Others (most notably the 16-bit computers) can expand to 512K bytes or more. A need for future expansion of primary storage would arise only if an application required a larger primary storage or if future plans included multi-user operation.

Secondary Storage Capacity. Whether secondary storage capacity is sufficient to support the necessary libraries of programs and the application files should be determined. Secondary storage consists of both disks and diskettes; capacity of these devices varies considerably according to computer system. The capacity requirements of all planned applications must be added to determine total secondary storage capacity required. Two aspects of this capacity should be separately evaluated.

- The programs and data files that must be simultaneously available should be determined. Online disk and/or diskette capacity need only be sufficient for this requirement. For example, if word processing and accounting applications will not be carried out concurrently, different diskettes can be used for the files and programs of each application, thus relaxing the overall secondary storage requirement. Most hard disks are not removable and the files for all applications must be simultaneously present.
- Future expansion of existing applications and purchase of others and their potential file space needs should be considered. It should be ensured that either existing disks and diskettes can be upgraded to have greater capacity or that additional disks and/or diskettes can be added to the system.

Warranty and Maintenance

For any hardware system considered, the type of warranty and maintenance service needs should be specified and their availability checked. Various maintenance plans are available for small computer systems. Alternatives range from contracts that cover maintenance on a fixed-annual-cost basis to simple time-and-materials charges for individual repairs. Maintenance may be available on-site and/or on a carry-in basis. Maintenance may involve actual repair of equipment or replacement by an equivalent unit; the latter is very important in assessing a hardware system. A maintenance contract that replaces faulty hardware with an equivalent system enables a quick return to use. Equipment repair can result in delays, depending on the nature of the problem and the availability of adequately trained repair personnel.

If the small computer system consists of modules purchased from separate sources, all maintenance may not be available from a single source. For carry-in maintenance contracts, this may not be a problem. In any case, the suitability of a single or multiple source for maintenance should be investigated before committing to a specific computer system.

Costs vary considerably depending on the particular hardware system and type of maintenance plan selected. If the system depends on the skills of the maintenance staff, it is necessary to evaluate the competence and completeness of the maintenance offered; this includes number of people, their training, and the availability of spare parts from inventory. Recommendations from other users regarding the hardware being considered are invaluable, as is discussing their experiences with the equipment vendor and maintenance supplier.

Environmental Considerations

The environment in which the small computer will operate should be specified, and whether warranty and maintenance contracts permit operation in that environment should be verified. Most environments in which small computers are used are compatible with war-

rently and maintenance constraints regarding temperature and humidity limits. Exceptions occur, of course, and must be carefully checked. A more severe environmental constraint is the computer's electrical supply. Warranty and maintenance contracts often require that the equipment be operated on a separate electrical line to preclude interference from other equipment. Any equipment that places momentary heavy loads on the power lines (e.g., motors starting) play havoc with small computer systems. Moving small business computers into a business environment may cause a problem by necessitating special isolated electrical lines.

Some small computer systems are especially susceptible to high-frequency electrical disturbance, which often occurs around such office machinery as copiers and results in voltage "spikes" and "drop-outs" on the power lines. Although short in duration, spikes can have two effects on small business computers. They can cause failure of sensitive electronic components if the computer system power supply is not properly filtered. They can also result in momentary errors in computer operation, which can cause a running program to fail or err with an attendant loss of data or files. It is important to determine whether the hardware system being considered is susceptible to such transients; if so, the specifications should include some form of a filter for the electrical power line. Such filters are very low in cost compared to the cost of recovering from a transient failure.

The small computer's physical packaging may also be important from an environmental standpoint. For example, some devices (diskettes in particular) are added to small computers by connecting physically separate devices to the computer; this results in the small business computer system consisting of numerous separate devices with a tangled mess of cable. Motion-sensitive disks are another related consideration because they can fall out of alignment when movement or vibration occurs. As a result, a small computer system that must be moved occasionally could pose a problem from a maintenance standpoint. Physical packaging of systems and associated problems can be evaluated before consideration and purchase.

Communications

The requirements for communications between small computers and other systems should be specified, and the adequacy of hardware support of this communication should be verified. Although support of communications with other computers is usually a software function, several situations warrant hardware support. Communications between computers is an area with a huge growth potential. Several areas of communications requiring hardware support should be considered.

Asynchronous Connection to Another Computer through a Modem. Such hardware support is the most common and is usually available for all speeds likely to be desired. It is necessary only to determine that the hardware devices and speed ranges of up to 9,600 baud are available.

Synchronous Connection to Another Computer through a Modem. This form of communication hardware support is far less standard and must be checked carefully to ensure compatibility with intended applications. Applications range from use of the small computer as a means of transferring files to and from remote DP computers (RJE communication) to use of the small computer as a terminal to a DP system (e.g., an IBM 3270 terminal emulator). In both cases, a combination of special hardware and software, which is not available on all small computers, is necessary.

Connection of Multiple Small Computers into a Local Area Network for Sharing Programs and Data Files. A local area network (LAN) involves high-speed communications with special protocols and requires special interface hardware at each small computer as well as special software to support the communications. This form is currently the least common but is expected to become widely used in the future. Its need arises in businesses that use multiple small computers and that must communicate data files to specific users and permit results produced in one machine to be used elsewhere. Little standardization has yet occurred in this area.

The previous hardware considerations can be evaluated before system purchase and thus do not require acceptance testing after delivery. They are, however, exceedingly important to the success of a small computer system and should be satisfied by the small computer system that is selected.

ACCEPTANCE TESTING FOR INDIVIDUAL HARDWARE COMPONENTS

In most cases, system testing is carried out prior to purchase because of the general availability of software packages and the necessity of testing them using the I/O devices with which they are to be used. It should be emphasized that all such tests should be carried out on a configuration identical to that to be purchased. Individual hardware units must also be acceptance tested. Each hardware module of the small computer system is discussed in the following sections from an acceptance-testing standpoint.

The Processor Unit

The heart of the small computer system, the processor is usually packaged in a module with the primary power supply, primary memory, and all I/O interfaces (i.e., electronic plug-in boards that permit the connection of specific devices to the computer). Five aspects of the processor module must be acceptance tested before purchase.

Maximum Primary Storage. The maximum primary storage that can be supported by a processor is a characteristic of the processor itself; however, in small computer processors, the total potential is not always available to the user. The maximum primary storage

available for the computer being considered should be determined. This represents the capacity available for future expansion if the need arises.

Capacity Limit. In order to add more memory or any device to the computer, slots must be available in the processor module into which the boards can be plugged. The number of slots available is another important capacity limit and must be determined prior to purchase. In particular, the configuration of devices proposed for the small computer leaves a certain number of slots available for expansion, which must be shared among additional primary storage and added devices.

Expansion Capability. A low limit on the number of slots available for expansion is common in small computers, because this limits the cost of the processor module itself. If future expansion (e.g., more devices, multiple users) is planned and if the number of slots is insufficient, the availability of an expansion module, which connects to the processor module via a cable and contains additional empty slots for expansion, must be ensured. Furthermore, the constraints placed on locating items should be determined (e.g., primary, diskette, and disk storage within the primary and/or the expansion module). In all cases, the objective is to determine the system's capacity limits prior to purchase.

Speed. Although 16-bit processors offer the potential for increased speed, it is not always realized in small computers. If processor speed is important, it must be checked before purchase. An internal clock is used in all electronic computer circuitry; its speed determines the speed of computation. Generally, clock speed may vary for the same microprocessor (i.e., up to four times as fast) and produce a corresponding change in speed. Furthermore—and quite frequently in practice—the 16-bit microprocessor may not run faster than similar 8-bit, processor-based computers. Because the clock speed cannot be changed by the user, the only alternative is to predetermine if it is important.

The real measure of computer speed, however, is within the environment in which the machine is to be actually used. That is, the net effect of raw computer speed, operating system efficiency, I/O speed, and the efficiency of the actual application program is important. Therefore, in most cases, it is necessary and sufficient to check the speed of response of the small business computer with the desired applications running on a configuration identical to what will be used.

Input/Output. I/O devices are connected to the processor in two basic ways: direct memory access (DMA) and character-by-character (i.e., serial). DMA I/O is much faster, involving a block of characters transferred from a device (e.g., disk or diskette) directly into primary

storage or vice versa. Almost all computers use DMA for both disk and diskette I/O; this must be checked, however, because the high speed associated with DMA is crucial for most business applications involving much transfer of information to and from secondary storage. Because it is difficult to test business application packages in advance with large files (it is difficult and time-consuming to create the test files), the effect of slow I/O may not be apparent in running the application package. The vendor's literature may be useful in verifying the use of DMA for crucial devices.

If the small computer system is to be used with a range of nonstandard devices (e.g., for laboratory instrumentation), the availability of one of the industry-standard I/O buses—for example, the IEEE 696 (S-100) or IEEE 488—is important. Most instrumentation devices are available with interfaces to these standard buses. In addition to verifying that the standard bus hardware support is available, it is important to verify that corresponding software support is available in the selected operating system. As with all other prepurchase acceptance testing, there is no substitute for seeing the actual operation of such features that may be crucial to the computer system's success.

An interesting development is the advent of dual processors in recently introduced 16-bit small computers. The 16-bit processor is the system's primary processor. A second processor (usually an 8-bit) is provided for two purposes: it handles all I/O for the computer, thus enabling the 16-bit processor to handle the application itself, and the computer can be operated in a mode in which only the 8-bit processor is used, thus permitting the computer to run any software available for that processor. Typically, the 8-bit processor is used to run an operating system such as CP/M, which has been used for many years and for which there is a wealth of application software. The 16-bit processor is then used for new applications, thus providing the vendor with a bridge from 8- to new 16-bit processors without requiring the complete regeneration of all applications software for the newer processor.

If use of dual processors is contemplated, it is important to verify that the applications software functions properly and adequately on the system before purchase.

Acceptance testing of the processor after delivery must be limited to verification that the hardware is actually functioning properly. This should be carried out with several sets of tests.

- The vendor's diagnostic software should be used to verify correct system operation. Diagnostic software is important not only for acceptance testing but also for future maintenance. When a problem is suspected, it can be verified by using such software, which generally limits the problem to a specific module (e.g., processor, keyboard, display). Only that module need be returned to the vendor for service.
- The computer system and the operating system provided by the vendor should be exercised. Usually, the vendor supplies a detailed set of instructions for starting the system, loading the op-

erating system, backing up the software provided, and so on. All these steps must be followed during acceptance testing. In particular, such operation system utility functions as formatting, copying, and verifying contents of disks should be exercised to determine proper functioning of the hardware and software combination.

- These performance tests should be repeated after purchase using the combination of actual system configuration and application software. This acceptance test also ensures that the delivered software has been configured correctly for the delivered system, and that all devices have been properly cabled to the computer system.

The Keyboard

The keyboard is the most important human-machine interface and its significance should not be underestimated. Although one vendor may offer no choice among keyboards, different quality keyboards are available from other vendors. It is necessary to perform keyboard acceptance testing before purchase. The following must be considered.

Layout. The keyboard should conform to the standard QWERTY layout to permit touch typing; this by itself, however, is not sufficient. Layout of keys on the keyboard must be checked by a typist. For example, one vendor displaced the left shift key approximately half an inch from its normal position, annoying touch typists and resulting in errors. Such rearrangement of keys is usually caused by the introduction of special character keys that do not appear on the typical typewriter keyboard. No standards have been established in this area; thus, careful evaluation of the keyboard is necessary. Generally, the best keyboards adopt the IBM Selectric keyboard style, which is acceptable to most typists. Special character keys are then arranged around these keys. A type of keyboard that offers higher input rates with a completely different layout is the Dvorak style. The tradeoff between ease of use and retraining time, however, may outweigh the benefits of the change.

Feel and Sound. Keyboard feel and sound are also very important and must be evaluated by a typist. Keys should have concave upper surfaces for a comfortable finger fit. Physical movement of the keys when pressed should be discernible to provide positive feedback to the typist. Membrane keyboards lack this tactile attribute and should be accepted only after testing with the actual applications. Audible feedback is equally important. Some keyboards provide an audible mechanical sound when the keys are pressed; others generate the sound electrically and provide control over its volume level.

Special Character Keys. Special character keys are widely used on small computer systems. They vary from special printable characters that do not appear on the usual typewriter keyboard to special keys

called function keys whose purpose is defined by each program that uses them. Such keys are very useful in simplifying communications between the operator and the application programs; however, their physical appearance and layout must be evaluated for convenience, understandability, and ease of use.

A separate keypad for entering numerical information is also a common feature and useful for applications involving a great deal of numerical data entry. Some keyboards define multiple use of such keys by the use of locking or control keys; thus, when not used for the primary purpose, the key can be used for another. For example, many keyboards alternately use the numeric keys on the separate pad as cursor control keys. Prior to purchase, a typist should check for how natural the use of alternate key definitions is. A poorly designed keyboard can greatly frustrate the user.

Separate Keyboard. A keyboard that physically can be separated from the computer is useful. Such keyboards connect via a cable to the processor module and allow the placement of the processor, display, and keyboard to suit the operator's comfort and convenience.

Programmable Keyboard. A programmable keyboard is another useful feature that can simplify use of application software. The programmable characteristics can be a function of the keyboard itself or the operating system supporting the computer. In either case, these keyboards permit redefinition of the keys' meanings, thus allowing both function and special keys to assume meanings appropriate to a certain application program. In some cases, a key can be defined as a sequence of characters, which greatly simplifies entry of common information.

The Video Display

The video display is also important to the small computer system user. Unlike the keyboard, alternative displays are often available for use with a specific system. These different displays offer varying quality and features. The following characteristics should be evaluated and acceptance tested before display purchase or specification.

Screen Size. Screen size—both physical and in terms of display layout—must be evaluated for acceptability. Alphanumeric displays generally show 24 or 25 lines of 80 characters each. Using a display with fewer characters per line is frustrating, because it requires frequently shifting the display left and right to see the portion of lines that cannot be displayed on the screen. Because most application programs assume an 80-character width, it is difficult to modify software to use a display with less width. Some application programs assume a display width equal to that of a line printer (132 characters per line), thus conveniently displaying any report that can be printed. Most displays, however, do not support such line widths, unless an alternate character set that is physically smaller in size is used.

Others allow the user to scroll the text left or right to view these long lines, 80 characters at a time. Display appearance must be evaluated by the system user prior to purchase.

Special Characters. The display's ability to show special characters in a readable form is also important for many applications, particularly word processing. Thus, descenders for such characters as *p* or *q* should be displayed below the line for legibility. Combinations of characters are also often desirable on a display. For example, a word processing program should be able to display underlined text; most displays do not permit this. Both upper- and lower-case letters are necessary for almost all applications and should be a prerequisite for any display. Similarly, standard variations of displays (e.g., text highlighting, blinking cursor, reverse video) should also be available. All contribute to the display's appeal.

Character Appearance. The physical appearance of the screen characters and the display itself should also be evaluated. Characters should be sharp and in focus without wavering on the screen. Character lines should be straight. Extra spots on the screen, which indicate internal electrical noise, should be absent. The use of black characters on a white background and amber characters on a black background in monochrome displays is increasing; such contrast is easier on the eye. Screen reflection must be controlled either by coating the display, shielding it from overhead lights, or using a polarizing screen.

Physical Positioning. Proper physical positioning of the display facilitates its use. This includes either physical horizontal movement of the display (a simple task if the display is separate from the processor module and the keyboard) or ability to rotate the display. Equivalent vertical rotation is also important. The viewing angle of the display varies according to the table on which the display sits and the operator's height. Operators that wear bifocals or trifocals, for example, have to view the display through the reading sections of their glasses. A display at eye level then implies that the operator has to tilt his or her head back to view the display properly. Such considerations are very important to the user and can be evaluated only by having the user sit in front of the keyboard and display in an environment closely resembling the actual one in which the system will be used.

Graphics and Color. Graphic and color displays are becoming more common in small computer systems. The rate at which graphics are produced, their appearance, and the color range must be evaluated prior to system specification or purchase. Moderate and high resolution graphic systems differ significantly as do their prices. Color and graphics should be evaluated using the specific application programs that produce the graphic displays. Display responsiveness is facilitated if the display is memory mapped. This means that the

application programs write the characters or graphics to be displayed into a special section of memory, which is automatically displayed by the hardware and updated on each video scan of the display. More expensive graphic displays provide more than one such area of memory, thus allowing the display to be switched back and forth among several displays without wait time.

Secondary Storage

Almost all computer applications rely heavily on information stored in files on secondary devices (i.e., disks and diskettes). A computer's internal memory is not suited to long-term information storage, because it is too small and highly volatile. Most of the internal memory is used for storing currently executed programs; the remainder is used for storing the small amount of data currently being manipulated. As mentioned previously, acceptance testing involves the determination of the amount of secondary storage that must be online and available to application programs.

The most common media for long-term data storage on small computers is the diskette (also called the floppy disk). The primary advantage of using diskettes for storage is that they are inexpensive (about \$5.00) and can contain up to 1.2 megabytes of information for several years. They are also a removable media; thus, although a system has only one diskette drive, as many diskettes full of data as desired can be stored with only one at a time directly accessible to the computer.

There are currently three sizes of diskettes: 3-1/2-, 5-1/4-, and 8-inch diameters. The 8-inch is the original; it holds the most data (up to 1.2 megabytes) and also provides the fastest access to it. The 5-1/4-inch diskette provides up to 0.6 megabytes of storage and is typically somewhat slower for data access. The primary advantage of the smaller diskette is that the drives are 15 to 30 percent lower in cost. The recently introduced 3-1/2-inch diskettes are not yet fully standardized in diameter and remain untried.

Diskettes can be formatted in many ways. For example, there are hard- and soft-sectored diskettes, single and double density, single- and double-sided, and sector sizes of 128, 256, 512, and 1,024 bytes. Any one of these factors can make a diskette totally incompatible with a diskette written on another system or even written on the same system but with different parameters. Furthermore, a diskette written on one system may still be unreadable on another even though the parameters match if the software encoding of the information is not identical. The resulting confusion is only a problem if the data is likely to be moved from one system to another.

If such data movement is a consideration, 8-inch diskettes should be specified; they are currently the only ones that adhere to standard recording techniques. Even if the 8-inch diskette is chosen, however, the physical formatting particulars and the software encoding must be compatible. Software encoding is likely to be a problem if two dif-

ferent machines use different operating systems. This in turn favors such operating systems as CP/M and UNIX that can be found on many machines. This is a thorny issue and it is advisable to try transporting data between machines to prevent being locked into total incompatibility or to eliminate the need to write conversion programs.

Although diskettes and disks are generally reliable, loss of important data can occur if the disk surface is scratched or otherwise unreadable. Insurance against data loss is possible by periodically backing up the data on another diskette. Thus, if one diskette fails, the other will be available. This backup process is easily accomplished with two diskette drives—a software utility program is used to read one diskette and write the same data on the other. Having two diskette drives is highly recommended, as is the periodic backup of diskettes containing vital data. Unfortunately, because diskettes are usually so reliable, the need for data backup is often overlooked. Invariably, a diskette fails when least expected; re-creating the data can be very time-consuming and sometimes even impossible.

The speed of a small computer is greatly limited by the time it takes to access data from a diskette. A disk allows much faster access to data and offers much greater storage capacity (typically several megabytes). Most disks are nonremovable, however, and thus must be used somewhat differently than diskettes. The most frequently accessed files are usually stored on the disk; the remainder can be kept on diskettes. Diskettes are still necessary not only for storing less frequently used files but also to back up the disk contents against hardware failure. Disk backup may be much more complicated, because many diskettes may be needed to back up the contents of the larger disk. Although disks are generally more reliable than diskettes, backup is still necessary.

The following acceptance tests should be carried out for disks and diskettes.

Operating System Support. Before specifying or purchasing any disk, it should be ensured that the operating system selected actually supports the disk. This includes the ability to maintain program and data files on the disk and to boot, or start, the system from the disk.

Support of Alternate Sectors. Unlike diskettes, which can be discarded when a portion of the surface fails, disks are usually nonremovable and probably not replaceable under a maintenance contract. If a small part of the surface (i.e., a few sectors) becomes unusable, it is necessary that the operating system support the use of alternate sectors; that is, it should log the fact that certain sectors are bad and either ignore them or replace them with good sectors located elsewhere on the disk. This capability is not always available and must be checked before disk purchase.

Diagnostic Software. After delivery, the diagnostic software should be run on each diskette and disk drive. This diagnostic soft-

were should check the proper functioning of the secondary storage units in general as well as the proper rotational speed and alignment of read/write heads. Continued maintenance of disk and diskette drives is required to check speed and head alignment. Diagnostic software for this purpose should be included in the system's specification and used for acceptance testing after delivery.

Proper Operation. Proper operation of each diskette drive and the diskettes purchased with the system can be ensured by formatting diskettes in each drive, loading them with data, and verifying the correct storage of information on the diskette as well as its readability in drives other than the one in which the diskette was created. Operating system functions (e.g., format, copy, backup, and compare) for these operations are available. They will check not only the diskette drives but also the actual diskettes purchased. Unfortunately, experience indicates that some manufacturers' diskettes work well with some diskette drives but not with others. The computer supplier's recommendation for a source of diskettes should be heeded.

The Printer

Hard-copy output is necessary on all small computer systems; it is also one of the most difficult capabilities to provide adequately. The situation is complicated by the possible need for nonstandard forms sizes, preprinted forms that differ according to application, maximum size needed, and quality, speed, and volume of printing required.

Printers are divided into two general categories: serial (one-character-at-a-time) printers, which print at the rate of 15 to 150 characters per second or about 20 seconds to 3 minutes per page, and line (one-line-at-a-time) printers, whose speed starts at the upper limit of serial printers and can be at least 10 times faster. Line printers are expensive (approximately \$7,000 for a low-quality printer) and are rarely used with small computers. (Serial in this context does not refer to the method of data transmission between computer and peripheral, which can be either serial, parallel, or 20-mA current loop (TTY). The faster line printers, however, typically employ parallel communication.)

Serial printers are further divided into two categories: matrix printers and letter-quality printers. Matrix printers produce their characters using a grid of dots (5 x 7 for less expensive printers, 7 x 9 for better models). The quality of print is not adequate for most word processing applications. Letter-quality printers commonly use a fully formed character for printing. Types of printers include the IBM Selectric ball, the Diablo daisy wheel, and the NEC thimble. Letter-quality printers are usually limited to printing speeds of 30 to 50 characters per second. These printers usually offer either pica or elite type (10 or 12 characters per inch), changeable fonts, and print lines that vary in length from a minimum of 80 up to 132 characters.

Matrix serial printers are often selected if graphic characters are desired. They usually provide multiple character sets, a variety of graphic characters, and choice of character size, number of characters per line, and vertical spacing of lines.

Acceptance testing of printers must take place prior to purchase to ensure adequacy for the intended applications. The printer is often an integral part of an application program and must be evaluated in conjunction with that particular program. Generally, the following should be considered.

Application Program Needs. Printer selection should be based on the application program needs, including the quality and speed of printing required. The printer should be evaluated using the actual application program to ensure that proper printed output is attainable.

Operating System Support. The availability of operating system support of the printer that is selected should be verified. Small computers may permit connection of more than one printer. The operating system should direct printing to the appropriate printer without requiring modification of applications software. Of importance here is a peculiarity: some printers automatically insert line feeds whenever a carriage return is transmitted. Such a printer precludes use of a carriage return and then overtyping the line (e.g., for underlining purposes). Some operating systems assume that a line feed is required after a carriage return and insert it automatically; thus, a printer that does not need the extra line feed causes all printed output to double space. Such troublesome characteristics of printers and operating systems are extremely difficult to eliminate or fix after purchase and thus should be eliminated by selecting the proper computer, applications software, and printer.

Diagnostics. Most printers include built-in minimum diagnostics that check proper operation of the printing mechanisms and interface electronics. These diagnostics should be checked both before purchase and as an acceptance test after purchase. Often, small problems (e.g., alignment of print head or ribbon) can be checked with such software, saving a maintenance call. If processor diagnostics exist to further check out the printer (e.g., print standard lines for total checking of printer operation), it is advantageous to also use them as an acceptance test.

Noise Level. Printer noise can be a problem. The noise level should be checked prior to system purchase, which may be difficult because the large areas within a small-computer store do not duplicate the small office environment. The availability of noise-suppressing hoods or enclosures for printers should be verified if noise presents a problem.

Modems and Remote Computer Connections

Modems are devices for transferring data from one computer to another over a telephone line. They connect to standard serial interfaces on small business computers and generally do not cause a physical interconnection problem, because the interfaces are built to the EIA RS-232C standard. Most modems for small computers transfer data at a rate of 37.5 characters per second (300 baud); some have a rate as high as 1,200 characters per second (9,600 baud). Almost all interfaces support the low data rates and conform to the particular Bell signaling protocol. The following characteristics should be checked.

- Whether operating system support (or a separate communications program) exists for communication with a remote computer should be verified. This communication can be either for the purpose of acting as a terminal or for transferring files.
- If the computer is to be used in an environment where the host computer calls the remote user, the automatic-answer feature on the user's modem and corresponding support in the operating system are very desirable and should be checked prior to purchase.
- Automatic dialing of remote computers by the user is available on some modems and should be checked for compatibility and support by the operating system.

Other Devices

Other devices commonly connected to small business computers include light pens, plotting devices, digitizing tablets, analog and digital signal data acquisition devices, and magnetic tape units. Generally, it is necessary to check that hardware interfaces for the computer considered do exist and that software support through the operating system or separate programs is available. Each case must be considered individually. Usually, however, it is wise to consider carrying out any acceptance testing of such devices and their software prior to specification and purchase of a computer system; obtaining custom hardware and software support of most small computers can be costly and difficult.

CONCLUSION

Both general hardware-related problems and those unique to small computer systems can either be avoided or resolved early if the computer's features are carefully evaluated and acceptance tested. Too often, the small computer is initially effective but soon outgrows the application because of the need for access to data available only in the centralized computer facility. If the small computer cannot function as a terminal to access necessary data, it becomes ineffective and unused or requires expensive custom support. This article discusses hardware considerations and related acceptance testing to avoid this outcome.

USING MICROCOMPUTERS FOR MATERIAL REQUIREMENTS PLANNING

by: A. Eric Eastman, President
The A. Eric Eastman Company
West Bountiful UT

MICROCOMPUTERS AND MICROCOMPUTER APPLICATIONS

Computers are generally classified in three categories: mainframes, minicomputers, and microcomputers. The IBM 300 and 400 series computers, for example, are mainframes; the IBM System/34 and System/38 are examples of minicomputers; and the IBM Personal Computer, the Apple Computer Inc Apple II, and the Tandy Corp Radio Shack TRS-80 are examples of microcomputers.

Microcomputers generally offer from 32K (thousand) to 128K bytes or characters of processor memory and one or two diskette drives, each with a 180K- to 300K-byte storage capacity. Larger-capacity hard disk systems, called Winchester-type disk drives, are increasingly available, thus making microcomputers effective for a wider range of business applications. In business applications microcomputers also need printers. Typically, dot matrix printers capable of printing 80 or 132 characters per line at 80 characters per second are used. The typical cost for business microcomputer systems ranges from \$2,000 to \$7,000 for hardware and from \$200 to \$7,000 for software programs, depending on the applications.

Use of microcomputers in business is growing rapidly as managers discover more uses for them. Software Arts Inc's VisiCalc, the modeling and forecasting spreadsheet program, and various word processing packages are already popular applications that have enhanced planning and correspondence activities in small businesses. Material requirements planning (mnp) is a business function that requires a computer because of the massive amounts of data that must be routinely stored and manipulated. Only recently, however, with the availability of Winchester-type disk drives for microcomputers, has computerized mnp become feasible for smaller manufacturers who could not afford the larger computers. This article discusses the use of microcomputers for running mnp, describing the functional and system requirements, startup, and methods for evaluating the feasibility of using a microcomputer.

mrp FEATURES AND ENVIRONMENTS RELATIVE TO MICROCOMPUTING

There are basically three types of material requirements planning systems: standalone mrp, closed-loop mrp, and mrp as a component of manufacturing resource planning (MRP). Standalone mrp merely schedules the timing and quantity of replenishment orders for both purchased and manufactured material. Closed-loop mrp adds capacity evaluation techniques to provide feedback to the system about the physical capability of doing what the schedule dictates. MRP adds another function to closed-loop mrp: the ability to track the financial impact of daily business operations and decisions. The costs of components are monitored and automatically accumulated in the assemblies to produce a continual picture of the cost of the final product. Purchase commitment figures are also supplied in time-phased format as well as work-in-process costs and the current and projected value of inventory. With this information manufacturing executives gain firm control of the business and can manage levels of financial commitment while balancing them against expected levels of service to the market.

There is no reason why a small manufacturer or a small division of a larger firm cannot have MRP on a microcomputer-based system. The key is the software, and the package can be designed for MRP if the software designer maintains simplicity. For example, an automatic interface of the financial data from the mrp system and the general ledger system should be avoided. However, costed reports certainly can be produced, and files can be up-loaded to a larger host computer's financial system, or even transferred to another financial package on the microcomputer.

While net change mrp systems appear to have advantages, mrp on microcomputers should operate in the regenerative mode. The regenerative method takes longer because it replans all active parts in the bill of material, while net change replans only those assemblies (and their components) affected by changes. However, the regenerative method presents fewer potential problems to the user. First, because it replans all parts in the bill each week (or as frequently as the generation is run), this method has a tendency to clean up automatically or identify problems that may have been caused by human error. Second, tracing the effect of changes in inventory status is easier with regenerative mrp than net change. Third, the regenerative method is less "nervous." For example, it will not suggest (as net change systems typically do) that a work order, put on a machine in the morning, be taken off the machine that afternoon to favor the recent discovery of some urgently needed part.

Environmental considerations that affect the advisability of using a microcomputer for mrp are the length of the planning horizon and the complexity of the bill of material. The length of the planning horizon is the time from first order of lowest level parts in the bill to shipment of the final product. If it exceeds one year, then only larger computers should be considered. When too many time buckets are

involved in the generation of mrp outputs, the microcomputer takes longer than is convenient or reasonable to complete the job. Also, extremely long planning horizons usually indicate the existence of complications that preclude the use of a microcomputer for mrp. The Boeing Company, for example, with long lead times for planes costing millions of dollars each and pegged for specific customers, needs a more sophisticated manufacturing system than is feasible even using minicomputers.

If the bill of material is complex, with many features and options such as those in the automobile industry, mrp on microcomputers should be considered carefully. Frequently, however, complex bills simply result from traditional methods; with proper training in restructuring techniques, manufacturers can simplify bills and, consequently, processes.

Full-level pegging and assigning quantities to planned orders by economic order quantity (EOQ) should be avoided on microcomputer systems. Full-level pegging produces a report that is essentially a full "where-used" list of the entire bill of material. This report produces large amounts of paper and requires hours to process. A much better method, the interactive single-level pegging, allows level-by-level tracing through the bill of material for specific parent/component relationships. Dynamic EOQ methods such as part period balancing, least total cost, least unit cost, and look ahead, look back assume too much decision-making authority for order quantities. The best method of assigning order quantities on microcomputers is lot for lot. This method allows complete freedom of quantity selection.

The manufacturer who investigates mrp on microcomputers must recognize the tendency to overcomplicate mrp systems. Extra features, functions, and capabilities detract from a basically simple concept. They can, therefore, degrade performance on the whole system.

Feasibility Guidelines

The following guidelines for maximum system volumes can be used to evaluate the feasibility of a microcomputer-based mrp system:

Number of unique part numbers in the inventory	3,000
Number of parent/component relationships	6,000
Number of work centers on the shop floor	50
Number of operations per average work order	100

The more complex the bill of material, the more care should be taken to ensure that the microcomputer system can handle it.

Beyond this list of criteria, general business judgment should prevail. If a company is small enough to manually track the need and timing for replenishment orders, it may not need mrp. Despite benefits from the cost roll-up and capacity features, if maintaining the

necessary files comes close to looking like a redundant task, justifying the effort will be difficult. If, on the other hand, late deliveries, work stoppage caused by missing parts needed to complete assemblies, a conviction that inventory investment should be lower than it is, and a general lack of control are a problem, a company would benefit from mnp.

Is a particular environment suited to mnp? The answer lies not in the physical environment, per se, but in the managerial philosophy. Widely different manufacturing companies experience similar control problems and operational environments. Identical mnp systems can work equally well in many environments, yet few companies are convinced that this is true. mnp works best in an environment where the bill of material is multilevel and is fairly stable, with few options; in a make-to-stock shop, where large production runs are possible; where the accounting system uses standard costs that do not change often; and where purchased material is easily acquired with short lead times. However, any other manufacturing management system or philosophy would work as well in such an environment. mnp becomes invaluable in uncertain environments because nothing else will provide as much visibility and control. But mnp will not work in any environment unless the manufacturing manager becomes skilled in its capabilities.

mnp MICROCOMPUTER SYSTEM DESIGN

Software for mnp on microcomputers is not yet available in abundance. Although only a handful of packages are available, more will come in the near future. A useful starting point for system design is to evaluate the available software, then let the software determine the hardware, within targeted cost constraints. Such publications as *PC Magazine*, *Softalk*, *Personal Computing*, *Creative Computing*, and the *ICP Software Directory: Business Applications for Microcomputers* are good reference sources. Local American Production and Inventory Control Society (APICS) chapters are also a good resource.

Consultants can also help. Again, local APICS chapters know who they are and where they are located. If consultants are used, a careful evaluation should be made to determine whether their philosophy is appropriate. This prevents a company from wasting time arguing operational philosophy and procedure.

Multiterminal Configurations

When considering mnp on a microcomputer, the small manufacturer should consider the following questions as a preliminary analysis:

- How many people will participate in the maintenance and operation of mnp?
- If more than one person will use the microcomputer, will any functions need to run concurrently? For example, will master production schedule maintenance normally occur at the same time that receipts and issues to the stock room will be entered?

Will purchase orders and shop floor orders need to be maintained concurrently? And will someone want to find where a part is used in the bill of material at the same time that someone else wants to query the stock quantity of another part?

- If significant use of the system is anticipated, can this use be managed by printed reports and batch updating?

If this preliminary analysis indicates that more than one terminal will be required, then the company must determine how many will be needed. It is important to separate the essential requirements from the enhancements. If, after doing so, the need for more than four terminals is established, then the company's size or complexity is too great for a microcomputer. If four terminals or less seem sufficient, then a multiterminal or shared-disk system is feasible.

Multiterminal systems for microcomputers are among the newest capabilities in the current market. The competition among vendors supplying this market is intense. Prospective users should be careful, therefore, and solicit unbiased, third-party assistance to ensure that requirements are met with shared-disk systems.

In multiterminal systems each microcomputer operates as a complete standalone computer and not merely a terminal. However, each shares a single disk storage system with the other microcomputer units. One of the microcomputers acts as a host computer and needs special software for controlling all access to the disk system. If all the microcomputers connected to the disk system need to access different files simultaneously, the host computer services them one at a time. Only a slight reduction in response time can be detected in the host computer. If, however, two or more of the microcomputers need to access the same disk file at the same time, the system determines which one may access the file, and then issues "device not ready" messages to the others. The requesting microcomputers must keep trying until the one that has access is finished with the file. Competition for access to storage will affect response time, but if no more than four computers are connected to the system, the response time should be acceptable. Furthermore, if users manage to coordinate their requests to the same files, the work flow should not be hampered.

Microcomputer shared-disk system operation is similar to that of large multiterminal computers. A large computer actually does only one thing at a time. Its speed as it services multiple-user requests creates the illusion that tasks are performed simultaneously. However, even a large computer can become bogged down by many simultaneous requests. To avoid excessive response time, shared-disk systems require use of the fastest possible microcomputer, effectively dictating 16-bit microcomputers, which are much faster than the older 8-bit microcomputers.

Hardware Requirements

Even in the small manufacturing company, the amount of data manipulation required for mrp is overwhelming. Each quantity required

in each time period (typically weekly for one year) for each part in the bill of material can be moved or changed every time an mrp regeneration is processed. Depending on the number of parts in the manufacturer's bill of material, the memory requirement of the computer could easily exceed 64K bytes of memory. Such 8-bit microcomputers as Apple II and Radio Shack's TRS-80 II cannot exceed 64K bytes of memory, but the 16-bit machines can have memory of more than 1,000K, or one million characters. As discussed in the preceding section, 16-bit microcomputers are usually faster than the 8-bit microcomputers, and regenerating mrp requires a significant amount of time. It is not uncommon for even the larger computers to take one hour per 1,000 parts for mrp regeneration. Speed is, therefore, very important in the choice of the microcomputer and effectively rules out 8-bit microcomputers as candidates.

Because of their speed and size, the IBM Personal Computer and the Apple III are clearly the most likely candidates for mrp by the small manufacturer. Other computers such as the Altos Computer Systems 8600 and Series 5 systems, and the CBM 8000 systems from Commodore Business Machines are alternatives. An additional consideration is that the IBM and the Apple, already very popular, will attract more software vendors to develop mrp systems. However, any microcomputer with enough memory, hard disk, and good software will handle mrp in a small company.

In general, the micro should have at least 128K bytes of memory to handle the indexes to the mrp files and at least 5M bytes (megabytes or million characters) of disk storage. It should be equipped with a printer that can print 132 characters per line, because many mrp reports require more printed columns than a standard typewritten page can accommodate.

Software Requirements

The software for an mrp system can be written with an interpretive style language processor or a compiler style processor. Execution speed and flexibility are two major considerations.

Interpretive style software runs slower because the language processor must interpret each statement in the program, convert it to machine language or object code, and then execute the statement. A compiler, on the other hand, has already converted all the statements into object code, and therefore produces faster-running programs. Compiled programs are rigid and inflexible, however, and when changes need to be made they must be recompiled. Programs stored in interpretive style are easier to change, thus easier to maintain. Because interpretive systems can always be compiled, however, a logical approach is to acquire an interpretive system and have it compiled if it is too slow.

Operations Considerations

When investigating a microcomputer-based system, the prospective user should look for easy and straightforward file backup and

recovery procedures and require a demonstration of these procedures. The procedures should be easy to perform. The system should be designed on the philosophy that because problems are inevitable, ready solutions must be available.

Automatic security measures are desirable only on the large computers. They are not required on microcomputers, and they will only degrade system performance. The best security, after all, is responsible users and good operating practices.

FINAL CONSIDERATION: THE VALUE OF THE EFFORT

Will it be worth the effort? Aside from the spirit of adventure, the challenge of change, and the desire to outdo the competition, msp on microcomputers is a worthwhile opportunity. Within one year of the first ventured step, management could reduce inventory investment by 25 percent, increase sales by 5 to 10 percent, and improve productivity by 5 to 15 percent. Few techniques currently known have the potential for such a dramatic impact on both sides of the return-on-investment equation. Small manufacturers, with their ability to evaluate new tools and to make decisions more quickly than the average large manufacturer, will become a major market for microcomputer-based manufacturing systems.

Implementing msp, however, requires an especially firm commitment of effort and resources by manufacturers who want to see the project succeed. Change and uncertainty will be introduced to the operation, and this can cause resistance from key people. Frustration will surface as bills of material are structured and restructured until they are correct and as record errors and human mistakes create false starts. But once results are evident and benefits start to accrue, a deliberate, logical work flow will materialize.

MICROCOMPUTER ADMINISTRATION POLICY

by: Ken Storenipher
Illinois Department of Transportation
Springfield IL

GENERAL POLICIES AND RESPONSIBILITIES

Microcomputers play an important role in the information services provided to an organization, and management must participate in selecting, evaluating, and implementing them. Without comprehensive management or control, acquiring a microcomputer can lead to frustration, confusion, and overspending. With constructive implementation, developed and monitored by key managers within an organization, the microcomputer can become an extremely accessible information resource.

The Illinois Department of Transportation (IDOT) hoped to develop, before purchase and installation, a strategic policy for implementing microcomputers. A policy report was designed to inform IDOT personnel of their responsibilities in microcomputer selection and operation. The policy also outlined the role of key IDOT managers in helping select the appropriate, cost-effective microcomputer hardware and software as well as in developing the role of key IDOT staff in supporting microcomputer hardware, software, and documentation. Under this policy, these managers also are responsible for helping users identify problems after buying and installing microcomputers.

The goal of this microcomputer policy is to help managers become informed consumers in the microcomputer area; this requires the assistance of specific staff members because of rapid technological change, the number and variety of hardware and software vendors, and the price of inappropriate or uninformed decisions regarding hardware or software purchases. The technical support staff should also look at a comprehensive policy of microcomputer integration with word processing equipment, data processing equipment, and other office automation support components.

To help managers and technical support assess microcomputer requests from various departments, an evaluation process should be instituted. It should include, but not be limited to, these topics: administration of microcomputers, hardware and software evaluation and documentation, training of new users, maintenance and support of microcomputers, informational support of users, and necessary customized applications software.

The most important considerations in developing a microcomputer policy are:

- Documenting the new organizational structure associated with the microcomputers
- Examining management's monitoring and control of the new information resource
- Determining the organization's information needs and what the available technology can provide

Management should recognize the microcomputer's potential in planning budgets, making cost projections, and developing financial forecasts and projection programs (i.e., spreadsheet packages). These projections can also be interfaced with graphics programs so that visual presentations can be incorporated into reports. The ability of the microcomputer to perform many functions is a rather consideration. The microcomputer can be used as a word processor, for example, to support office management functions, enabling managers to develop memos and brief reports without resorting to the typing pool.

Information flow is possible between microcomputers to enhance their flexibility, enabling managers to transmit information by electronic mail; that is, short messages, memos, and documents usually sent via telephone can be transmitted between microcomputers within an organization or across the country. This microcomputer function is very attractive because it eliminates "telephone tag" with other administrators, since such transmissions are fully automated, without operator intervention.

The affordability of microcomputers means that information processing that once could be performed only at certain terminals in selected areas tied into a large mainframe computer can now be performed by any user at a much lower cost. The affordability factor, however, may prompt the purchase of many of these units before a comprehensive policy or plan is set forth. The impact of gross purchases without a strategic plan for implementation can have serious cost/performance consequences.

An important component of the microcomputer policy should be a methodology for comprehensive evaluation and understanding of the microcomputer's primary and peripheral equipment and software. Although managers involved in implementing a microcomputer policy are not directly involved with the daily activities of microcomputer support, they must thoroughly understand the terminology and have a working knowledge of the equipment and software if they are to be effective in dealing with technical staff and vendors both before and after a sale.

ADMINISTRATION

Administrative considerations of a microcomputer policy are subject to change, but typical ones include:

- The selection process

- Examination of lease, purchase, and maintenance agreements
- Review of the necessary consumable supplies to support the microcomputer project
- Examination of security aspects if applicable
- Inventory assignments
- A cost/benefit format for the microcomputers.

The Selection Process

An administrative consideration is examining how a microcomputer or group of microcomputers is requested for a particular area. Complete documentation of the request procedure is necessary to ensure the use of appropriate organizational channels.

In order to assist microcomputer users in the analysis and selection process, IDOT outlined steps for requesting microcomputer services. These procedures aided the IDOT staff in microcomputer selection and also outlined the integration of other data processing and word processing services in specific applications when a microprocessor was inappropriate.

The procedures were designed to maximize the resources of available staff and minimize the time and cost lost through inappropriate hardware/software selections. The procedures are as follows:

1. An individual requests automated services to a specific IDOT bureau. It should be noted that microcomputers were not initially deemed appropriate until an analysis of the user's needs was completed.
2. A form requesting DP services (not specifically microcomputers) is completed and transmitted to the DP manager within IDOT.
3. The form is reviewed by the DP manager and assigned priority in accordance with IDOT's information processing goals.
4. Notification of implementation is transmitted back to the individual requesting information services.
5. The DP manager then meets with the appropriate staff to assign personnel to the user requesting information services.
6. The assigned information processing personnel meet with the user to perform a definition of requirements, using a Warner-Orr methodology.
7. Upon completion of the requirements and definition analysis, hardware and software requirements are specified by the analysis team.
8. Based on the data obtained through the functional requirements definition, a determination is made to review the equipment before purchase (if the requirements definition indicated that a microcomputer and appropriate software could fulfill these requirements). Supportive information (e.g., an evaluation) is completed with the assistance of the appropriate staff.
9. The user and the assigned analysis staff develop a request for a proposal and outline the minimal functional checklist for the equipment.

10. The user and the information processing analyst review vendor bid submissions.
11. A vendor is selected.
12. The information analysis team and appropriate personnel install equipment.
13. The user is trained off-site through IDOT's information processing section; training at the actual work site with the new equipment is a phased approach.
14. Maintenance and support are maintained on an ongoing basis by the appropriate personnel.

Throughout the request procedure, management judges the information request in light of the analysis of the user's needs and the technology that would best fulfill them, rather than in terms of the equipment that the user wants. Information processing or information requests eventually evolve into combined services of the microcomputer, word processing equipment, minicomputers, and large host mainframes. Therefore, managers assigned to working with microcomputers must confer with others as part of a committee on project requests and implementation, or they must report to higher management to avoid duplicating information services or selecting inappropriate equipment.

Lease, Purchase, and Maintenance Agreements

IDOT wanted a policy on leasing agreements for all its DP equipment because current technology can become outdated so quickly. Unfortunately, microcomputer costs are so low that many vendors do not have any type of lease agreement. Some retail stores do rent and lease equipment; the leasing agreements vary and thus demand a knowledge of specific contractual requirements before any form of lease is entered.

A lease/purchase agreement (i.e., the actual contract) should be thoroughly reviewed before entering into it. This is critical in terms of equipment replacement or service, especially when it is discovered after implementation that heavy use necessitates replacement or repair. Management must coordinate the maintenance staff to replace a malfunctioning unit in the least possible time. This can be accomplished in one of two ways:

- Because of low microcomputer costs, it is possible for the staff maintaining the microcomputers to have spares at their disposal.
- A leasing agreement can provide for repair or replacement by the retailer within 24 hours.

The technical expertise of retailers varies greatly. The best insurance for maintenance is having in-house staff with a working knowledge of the equipment and the ability to perform light maintenance. If, on the other hand, the staff does perform such light maintenance, the vendor's maintenance agreement or replacement policy may be voided. It is very important to review warranty provisions in purchase and lease agreements to ascertain how they specify user sup-

port as compared to retail-vendor support; this reduces the chances of voiding equipment warranty through in-house support.

Consumable Supplies

The manager's job in regard to consumable supplies should not deviate from present organizational responsibilities of those in charge of ordering them. Initially, those staff members ordering consumable supplies should be assisted by the manager in the review of recommendations by the vendors.

Consumable supplies include:

- 5-1/4-inch or 8-inch diskettes, the recording medium for the microcomputer
- Paper for any type of printer
- Mailing labels if applicable
- Print wheels if a letter-quality printer is used
- Ribbon cartridges if either a matrix printer or letter-quality printer is used

It is important that the vendor-specified print wheels be used with the letter-quality printers calling for them. The consequences of using subquality print wheels with a letter-quality printer is reduced print-wheels life (which cancels the cost-saving factor). In this case it is wise to consider the vendor's recommendations.

Security

Security considerations vary according to the organization and workstations within it. Organization and user workstation analysis should indicate the security requirements. Managers should ensure prevention of data theft and backups of secure information contained on diskettes; however, the best security for such information is to simply lock up the diskettes and store them where they cannot be accessed by unauthorized personnel.

Some software vendors offer security software that can be used with diskettes; however, the user may fail to understand thoroughly how that security encryption scheme works. If a software maintenance problem points to damaged secure information on a diskette, it becomes very difficult to recover that information. A management consideration regarding security is how to enforce a security policy that is as simple as possible for the users, is not time-consuming, does not establish a whole new organizational structure, and is easy to implement. Extensive security schemes may look attractive because of their complexity, but this may also hinder the user in implementing the new equipment.

Inventory Assignments

Inventory number assignments are necessary when the new equipment arrives but should require no additional staff. A routine organizational structure for assigning numbers should be established. It may be necessary, however, to develop a policy regarding software

inventory assignments. Because a great deal of software is maintained by users rather than at a central repository, management must keep track of software lending between users. Another factor to be considered is the relatively light weight of microcomputers and the peripheral equipment, making them easy to steal. IDOT requires that any room containing microcomputer equipment be locked during designated hours. In addition, no equipment leaves the office without the signature of the appropriate manager.

Cost/Benefit Analysis

IDOT viewed its microcomputer implementation as a cost benefit because text and management support programs that had been run through a large mainframe computer using telecommunications and time-sharing options could now be operated in a standalone mode. This saved the usage fee for a large host computer that was charged to IDOT.

A more comprehensive analysis format is a cost-avoidance one, in which microcomputers are the option over installing other terminals and enlarging the network tied into a large host computer. Microcomputers eliminate phone and telecommunications costs, CPU time costs, and large vendor terminal costs. In addition, with the implementation of microcomputers as alternatives to word processors, the administrative support staff can be far better used because of time savings with very comprehensive software available to microcomputers; thus, hiring additional programming staff because of the volume of administrative support work is unnecessary.

In the final analysis, a cost/benefit or cost-avoidance analysis is only as good as its developer. The best cost/benefit or cost-avoidance analysis can only give trends or indications of where some of those cost factors may lie. Therefore, management should be aware that the analysis is only a support component of the overall justification for a microcomputer project.

DEVELOPMENT AND TRAINING

A comprehensive development and training program for all individuals associated with microcomputer implementation, maintenance, and support should be incorporated into a microcomputer implementation policy. An educational plan specific to managers and to technical, professional, and clerical or support staff should be developed. Consideration should also be given to those with expertise in using microcomputers or DP equipment; thus, their training can be in the form of self-instruction.

The objective of any development and training program is to acquaint the new users as quickly as possible with the appropriate hardware and software. IDOT recommended two-phased training. The first phase is training with the new equipment outside the user's normal work area. This proves valuable because it gives individuals

time to gain an in-depth understanding of their new equipment before using it. The later phase consists of training tailored to particular user work areas and applications. Management should also be sympathetic to the time that individuals must spend away from their desks during the training period. The cost in time lost through training will be repaid, since this two-phased approach will ensure better use of the equipment in less time.

The technical staff should have a more intensive training program than users. It should involve a thorough understanding of such areas as:

- Microprocessor systems
 - RAM
 - ROM
 - I/O routines
 - Memory-mapped I/O
 - Chip architecture
 - Bus architecture
- Disk storage
 - Floppy disks
 - Hard Winchester disks
 - Logic assemblies
 - Mechanical subassemblies
- Printers
 - Dot matrix
 - Character impact
- Modems
- Monitors/CRTs
- Operating systems
- Clocking assemblies
- Installation procedures
- Application software
- Maintenance procedures

Education of the technical staff should be continual to increase knowledge in relation to the expanding technology. A plan of professional staff education should specify goals to be achieved through the training process. These goals should address how the new equipment is to be used under the supervision of their respective managers. Implementation should be codeveloped by the professional staff and the microcomputer team assigned to train users.

The initial phase is taught off-site in an area designed by the microcomputer training team; it is an intensive introduction to new hardware and software. The second phase involves the equipment at its permanent work site. The training program should satisfy the educational goals as specified in the development guidelines. The length of training for the professional staff depends on the needs of the trainees.

The training program for clerical and support users should also be specified in an educational plan, with specific goals for using the equipment in their area. All planning should be developed in accor-

dance with the directive of the respective bureau, department, or office in which the support staff will be working. If it has been determined through an implementation plan that the microcomputer user has had sufficient programming experience with microcomputers through other DP equipment, the microcomputer training team should develop a self-training program.

The plan contains specific goals for the self-training program; these goals should address how the new equipment will be used. Anyone qualified for this program should also undergo the two-phase educational program.

Individuals requiring education and training through the assistance of the microcomputer training team are evaluated on completing the program. This evaluation provides the microcomputer training team with methods for improving the program. All evaluative data for participants in the microcomputer training program should remain confidential and used only to help individuals use microcomputer hardware, software, and peripheral equipment.

MAINTENANCE AND SUPPORT

Managers should consider two major areas in terms of maintenance and support of the ongoing microcomputer program: hardware support and software support. Hardware support involves staff directly responsible for:

- Speed calibration tests
- Read/write verification tests
- RAM and ROM tests
- Communications board tests
- Documentation
- Problem determination

The software maintenance and support areas include:

- Analysis of change at user request
- Change policy
- Backup and storage
- New software release applications
- Documentation
- Problem determination
- Custom-developed applications for users

Management should consider the maintenance and technical support team as necessary as the training team, since it is responsible for the upkeep of both hardware and software. It should also be able to troubleshoot users' problems. After new equipment is installed and a new user is training, the team is still responsible for that equipment. The most critical aspect of operating a microcomputer network is maintaining the equipment and troubleshooting. The maintenance and support areas encompass a wide range of preventive maintenance. The list continually evolves according to user needs and hardware and software performance.

Hardware

Hardware support should be focused directly on areas that involve the highest degree of product failure. A fact to be kept in mind is that any component of a microcomputer with moving parts is more likely to fail than a solid-state one. That is why it is very important for the maintenance team to perform preventive maintenance on such units as the diskette drives, which have movable assemblies. The maintenance team should also be able to diagnose some problems of printers, especially letter-quality printers.

The tests involved in diskette maintenance are for speed calibration and read/write verification; these two tests determine if the motor is rotating at the proper revolutions per minute and the logic subassembly and read/write head is performing properly. The most common problem with diskette drives is input/output errors caused by inability to perform a read or write operation to translate the data from the diskette to the memory of the microcomputer or from the memory to the diskette. These two tests must be performed by the technical support team to prevent such occurrences.

The next major area in hardware maintenance support is RAM and ROM tests, which involve software operations that are loaded into the microcomputer to test an operation in which memory is used from available RAM and ROM. The only option available when failures occur in this area is to have the malfunctioning unit replaced; this requires an individual with a knowledge of electronics to replace chips or boards within the microcomputer. Advantages of having a technical support team able to perform RAM and ROM tests are that the team can isolate problems and specify memory areas where the failure may be occurring. This will isolate chips that the electronic specialist or vendor can replace.

The maintenance and support team should be able to determine problems in the communications area with the use of software that performs testing operations on the communications board or the modem being used. Again, this only focuses on the particular problem area; the vendor will have to replace the unit specified.

One of the important functions of the maintenance and support team is documenting problems. Any problem that is suspected and resolved or is ongoing should be so documented; thus, if these problems recur, the actions taken to resolve them have already been specified. In addition, documentation points to hardware and software weaknesses that may be occurring chronically. Once informed of this data, the vendor can replace the units or software involved. Without proper documentation of problems, the maintenance and support team has no reliability record of implemented hardware and software.

Software

Software maintenance and support (as critical as hardware support) necessitates a staff capable of analyzing software changes re-

requested by users. When changes are made to the existing software, management must develop a policy regarding change. This policy involves two considerations: whether the microcomputer software is protected and whether staff is available to resolve and debug a problem and reprogram, implement, and test a solution. If the software is copy-protected, the only available option to change that software lies with the vendor. Most software is flexible enough to incorporate many of the changes that users may request. If the software cannot accommodate a particular request, and it is copy-protected, management's only option is to contact the vendor about the change.

If the software is not copy-protected, programs can be changed at the user's request; this, however, involves personnel and time. Depending on the software, this can be as complicated as any major programming project. The change requested must be weighed against the amount of time and staff available to make the change and support it.

Backup and storage of software are other important maintenance functions. It becomes the responsibility of the maintenance and support team to maintain an adequate number of generations of backup and storage of program and diskettes. The real value of backups is in the time saved by organizations in not having to input information multiple times.

Software problem determination and documentation are also critical. Again, to assess the true performance of the software, a format should be established to document problems. The documentation should also specify the method used to determine the problem and resolve it. As stated previously, this provides valuable data regarding chronic problems and correcting of them.

Information Support

Information support is the use of current publications with specific information regarding the hardware and software in use or being considered. Information support can prove very valuable in avoiding unusable software or hardware currently on the market. It can indicate future hardware and software trends. A library of information on microcomputer publications and product evaluations should be established; this information can be tapped to provide managers with indices of product performance and evaluation before purchase.

RECOMMENDED ACTION

With a microcomputer policy, management is making an attempt to be well-informed consumers of this new informational support product. Microcomputers can perform a valuable function by providing data processing or information processing capabilities in an organization. Key considerations of microcomputer implementation include the analysis of those products being considered, a working knowledge of the technical specifications of a microcomputer system, an appropriate training and development program, and proper

maintenance and support for the units once they have been installed.

The random purchase and installation of microcomputers without the type of analysis discussed here may spell disaster. Without consideration for organizational goals and objectives, cost overruns may result. IDOT reviews a draft of a microcomputer policy to ensure that implementation and subsequent maintenance are comprehensive. Microcomputers may have begun as toys, but with technological advancements and improved software, managers are making them valuable tools and creating an alternative to large mainframe computers for supporting specific organizational needs.

New from Auerbach

MICROWORLD

Software/Hardware Selection Guide

Other Publications from Auerbach

The following is a partial list of all Auerbach products. All publications currently available.

AUERBACH Information Management Series

User Resources Management
Facilities Management
System Development Management
Data Center Operations Management
Data Communications Management
Data Base Management
ERP Auditing
Computer Configuration Management

AUERBACH Computer Technology Reports

Management

Security
Applications Software Reports
Systems Software Reports
Mainframe Reports
Data Communications Reports
Computer Technology Library

Office Technology

Management and Technology
Electronic Mail

Industry Applications

Inventory Management
Automated Material Handling and Storage
Manufacturing Resource Planning
Master Production Scheduling
Material Requirements Planning
Production Control Systems
Production Management

Telecommunications Management Series

Telecommunications Management
Telecommunications Selection Guide

Practices and Methodologies

Business Process Reengineering
Managing Customer Relationships

Journals and Newsletters

High Performance Computing
Telecommunications
Teleworld

For more information, call any Auerbach office or call

(800) 257-8162

(In New Jersey, (609) 662-2070)

or

Telex 831 464.

An Auerbach representative will be pleased to address your information needs!